

CONTRIBUTIONS
FROM THE
CUSHMAN FOUNDATION
FOR
FORAMINIFERAL RESEARCH

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Alfred R. Loeblich, Jr.

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29. A REVISION OF THE SMALLER FORAMINIFERA FROM THE MIOCENE OF THE VIENNA BASIN¹

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ABSTRACT.—A revision is made of a number of species of the classical Vienna Basin fauna, made famous by the studies of d'Orbigny, Reuss, Karrer and Czjzek. Seven new species and three new varieties are described.

INTRODUCTION

The Vienna or Intra-Alpine Basin (Suess) is a down-faulted graben, separating the Alps to the west from the Carpathians to the east, the basin itself striking SSW-NNE. In a geological, as well as in a geographical and historical sense, it has formed and still forms a passage in the towering Alpine chain, connecting the wide Hungarian plains with the southern German and Swiss plateaus. During the Miocene, it formed a narrow sea-strait between the large Pannonic Basin, which occupied the area of the actual Hungarian plains, and the marine Outer Alpine basin, which extended westward to the south German, Swiss and French Molassic basins, and eastward through the Molassic basins along the northern limb of the Carpathians to the Pontic Basin in southern Russia.

In the Vienna basin, the stratigraphic section has at its base a sandy-marly formation, attaining locally a thickness of 800 meters and directly overlying the eroded surface of the Alpine Flysch. In places there is a prominent basal breccia. This sandy facies or "Schlier" passes upwards into thick sandstones, the "Grunder Schichten." These formations have been determined to be Helvetian (Lower Vindobonian = Lower Middle Miocene) in age.

The Upper Vindobonian or Tortonian is represented by a series of marly clays, containing a very rich microfauna, which will be described later in more detail.

Whereas the Schlier and the Grunder Schichten contain faunas distinguished respectively by *Bathysiphonocyclammina* and *Cibicides-Elphidium*, indicating shallow water conditions of sedimentation (Grill, 1950), the Tortonian marls contain a fauna indicating a probably somewhat greater depth of sedimentation. The large number of different species with relatively few individuals indicates a rather warm, tropical or subtropical sea. This assumption is substantiated by the occurrence of *Amphistegina lessonii*.

The Tortonian marls pass laterally into the Leitha limestones to the southeast, which exhibit a shallow water facies and contain Bryozoa, *Lithothamnium*,

Echinolampas and *Amphistegina*. This limestone borders the Leitha Mountains, which formed an emergent area in the Tortonian sea during the Miocene.

The Tortonian passes upward into the Sarmatian sediments of shallow to brackish water facies, containing *Cerithia*, *Tapes*, etc. The almost exclusive occurrence of various species of *Elphidium* and *Rotalia* clearly indicates a shallow water depositional environment. It has been found possible, however, to subdivide the Sarmatian into a number of microfaunal zones (Grill, 1950).

Very early, in the middle of the last century, attention was attracted to the rich microfauna of these formations, particularly the Tortonian marls, as *Amphistegina* and several *Nodosariae* and *Nodogenerinae* are distinctly visible even with the naked eye. In 1846, Alcide d'Orbigny, the founder of systematic micropaleontology, published his beautiful work "Les Foraminifères fossiles du Bassin Tertiaire de Vienne," describing and figuring a large number of smaller Foraminifera, largely from collections made by von Hauer. This publication was soon followed by those of Czjzek (1848), Reuss (1848, 1850) and Karrer (1862, 1863, 1865, 1877). Numerous workers on smaller Foraminifera, throughout the world have since referred to species established by these pioneer authors. Many have been obliged, however, to do so indirectly, using the works of Brady, Cushman and others, as the original publications are rare and often difficult to obtain. It is with an eye to these difficulties that this paper has been written, attempting to give a critical review of those species which were actually found in our collection.

Acknowledgments.—Grateful acknowledgment is due to Drs. Alfred R. Loeblich, Jr., of the U. S. National Museum, and Helen Tappan Loeblich, for their kind assistance in correcting the English orthography and syntax. To Mr. C. W. Drooger I am much indebted for helpful criticism.

Samples were obtained from the following localities: Beethovenaussicht, Vienna; Stephansche Ziegelei, Sooss; Breyersche Ziegelei, Vöslau; Baden; Wiesen; Roth-Neusiedl; a railway cut near Vöslau, Ulrichskirchen.

The following species were obtained:

Haplophragmium agglutinans (d'Orbigny)
Haplophragmoides obliquicameratus Marks, n. sp.
Spiroplectammina carinata (d'Orbigny)
deperditia (d'Orbigny)
mariae (d'Orbigny)
pectinata (Reuss)

1. Contribution of the Paleontological Department of the University of Utrecht.

- Textularia abbreviata* d'Orbigny
mayeriana d'Orbigny
Siphotextularia concava (Karrer)
Bigenerina nodosaria d'Orbigny
Clavulinoides tricarınatus LeRoy
Karrerella siphonella (Reuss)
Martinottiella communis (d'Orbigny)
Articulina sulcata Reuss var. *nuda* Marks, n. var.
Quinqueloculina agglutinans d'Orbigny
akneriana d'Orbigny
auberiana d'Orbigny
boueana d'Orbigny
longirostra d'Orbigny
notata Reuss
pygmaea Reuss
rugosa d'Orbigny
Sigmollina tenuis (Czjzek)
Nummuloculina contraria (d'Orbigny)
Triloculina consobrina d'Orbigny
deciens Reuss
inflata d'Orbigny, 1846 (non d'Orbigny, 1826)
nitens Reuss
subrotunda (Montagu)
trigonula (Lamarek)
Flintina droogeri Marks, n. sp.
Pyrgo bulloides (d'Orbigny)
Robulus ariminensis (d'Orbigny)
clericii (Fornasini)
clericii (Fornasini) var. *carinata* Marks, n. var.
intermedius (d'Orbigny)
Marginulina costata (Batsch)
glabra d'Orbigny
glabra d'Orbigny var. *obesa* Cushman
hirsuta d'Orbigny
rugoso-costata d'Orbigny
Marginulinopsis pedum (d'Orbigny)
Dentalina bifurcata d'Orbigny
communis d'Orbigny
cf. scabra Reuss
Nodosaria longiscata d'Orbigny
rudis d'Orbigny
Lagena hexagona (Williamson)
striata (d'Orbigny)
sulcata (Walker and Jacob)
vulgaris Williamson
vulgaris Williamson var. *semistriata* (Williamson)
Guttulina austriaca d'Orbigny
irregularis (d'Orbigny)
Globulina gibba d'Orbigny
gibba d'Orbigny var. *globosa* von Münster
Glandulina laevigata d'Orbigny
Globorotalia menardii (d'Orbigny)
Nonion boueanum (d'Orbigny)
depressulum (Walker and Jacob)
granosum (d'Orbigny)
grateloupi (d'Orbigny)
perforatum (d'Orbigny)
pompilioides (Fichtel and Moll)
scaphum (Fichtel and Moll)
tuberculatum (d'Orbigny)
turgescens Cushman
Astrononion italicum Cushman and Edwards
Elphidium aculeatum (d'Orbigny)
advenum Cushman
antoninum (d'Orbigny)
crispum (Linné)
cryptostomum (Egger)
fichtelianum (d'Orbigny)
flexuosum (d'Orbigny)
flexuosum (d'Orbigny) var. *reussi* Marks, n. var.
hauerinum (d'Orbigny)
josephinum (d'Orbigny)
macellum (Fichtel and Moll)
minutum (Reuss)
reginum (d'Orbigny)
rugosum (d'Orbigny)
ungeri (Reuss)
Plectofrondicularia digitalis (Neugeboren)
Amphimorphina haueriana Neugeboren
Nodogenerina adolphina (d'Orbigny)
bradyi Cushman
consobrina (d'Orbigny)
elegans (d'Orbigny)
hirsuta (Soldani)
pauperata (d'Orbigny)
punctata (d'Orbigny)
scripta (d'Orbigny)
Bulimina aculeata d'Orbigny
elongata d'Orbigny
elongata d'Orbigny var. *lappa* Cushman and Parker
elongata d'Orbigny var. *subulata* Cushman and Parker
ovata d'Orbigny
pupoides d'Orbigny
pyrula d'Orbigny
striata d'Orbigny
Entosolenia marginata (Walker and Boys)
Virgulina schreibersiana Czjzek
Bolivina antiqua d'Orbigny
crassiseptata Marks, n. sp.
dilatata Reuss
fastigia Cushman
spatulata Williamson
plicatella Cushman var. *mera* Cushman and Ponton
trajectina Marks, n. sp.
viennensis Marks, n. sp.
Loxostomum digitale (d'Orbigny)
Bitubulogenerina reticulata Cushman
Reussella pulchra Cushman
spinulosa (Reuss)
spinulosa (Reuss) var. *laevigata* Cushman
Uvigerina aculeata d'Orbigny
multicostata LeRoy
pygmaea d'Orbigny
urnula d'Orbigny
urnula d'Orbigny var. *semiornata* (d'Orbigny)
venusta Franzénau
Hopkinsina bononiensis (Fornasini)
Angulogerina angulosa (Williamson)
Discorbis araucanus (d'Orbigny)
obtusum (d'Orbigny)
pileolum (d'Orbigny)
Valvulineria complanata (d'Orbigny)
Gyroidina soldanii d'Orbigny
Eponides haidingerii (d'Orbigny)
nanus (Reuss)
Rotalia viennensis (d'Orbigny)
ex. gr. beccarii (Linne)
Epistomina elegans (d'Orbigny)
Siphonina reticulata (Czjzek)
Cancris auriculus (Fichtel and Moll)
Asterigerina planorbis d'Orbigny
Amphistegina lessonii d'Orbigny
Ceratobulimina haueri (d'Orbigny)
Cassidulina crassa d'Orbigny
cruysi Marks, n. sp.
laevigata d'Orbigny
Allomorphina trigona Reuss
Chilostomella ovoidea Reuss
Pullenia bulloides (d'Orbigny)
miocenica Kleinpell
quinqueloba (Reuss)
Sphaeroidina bulloides d'Orbigny

Globigerina bulloides d'Orbigny
concinna Reuss
 cf. *inflata* d'Orbigny
Globigerinoides rubra (d'Orbigny)
triloba (Reuss)
Globigerinella aequilateralis (Brady)
Orbulina universa d'Orbigny
Anomalina sp.
Cibicides cf. *aknerianus* (d'Orbigny)
austriacus (d'Orbigny)
boueanus (d'Orbigny)
dutemplei (d'Orbigny)
lobatulus (Walker and Jacob)
ungerianus (d'Orbigny)

All specimens are in the collection of the Geological-Paleontological Institute of the State University of Utrecht, 320 Oude Gracht, catalogued under the numbers D. 31569 to D. 31890.

SYSTEMATIC DESCRIPTIONS

Family VERNEUILINIDAE

Genus *Clavulinoides* Cushman, 1936

Clavulinoides tricarinatus LeRoy

Plate 6, figure 1

Clavulinoides tricarinatus LeRoy, 1941, Colorado School of Mines Quart., vol. 36, no. 1, p. 20, pl. 3, figs. 92-93; BOOMGAART, 1949, p. 58, pl. 4, figs. 8, 9.

Test elongate, triangular in cross-section throughout, triserial in the early stage, then biserial, only a few chambers comprising the uniserial stage. Initial part enlarging rapidly, with the sides nearly parallel in the adult. Chambers distinct, increasing very gradually in size as added. Sutures rather distinct, limbate, slightly curved, very slightly if at all depressed, quite oblique in the early portion of the test, rather broad. Wall arenaceous, smoothly finished, periphery acute. Aperture terminal, rounded, with short neck or lip.

Length: 0.60 to 0.95 mm; diameter 0.32 mm.

Occurrence.—Beethovenaussicht, near Vienna.

Remarks.—Comparison with topotype material of *Clavulinoides tricarinatus* LeRoy shows no appreciable difference between the specimen found in the Vienna Basin and those from the East Indies.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMIINAE

Genus *Haplophragmium* Reuss, 1860

Haplophragmium agglutinans (d'Orbigny)

Spirolina agglutinans D'ORBIGNY, 1846, Foram. foss. Vienne, p. 137, pl. 7, figs. 10-12.

Haplophragmium agglutinans (d'Orbigny), BRADY, 1884, Rep. Challenger, vol. 9, p. 301, pl. 32, figs. 19-21, 24-26; MILLET, 1899, Jour. Micr. Soc., p. 357, pl. 5, fig. 1.

Test arenaceous, planispiral in the early stages, later chambers becoming uniserial, somewhat broader than

high, nearly circular in section. Wall coarsely arenaceous, sutures very indistinct or invisible, aperture terminal, simple, rounded.

Occurrence.—Roth-Neusiedl, Vienna Basin. Reported from the Pliocene of Italy, and living in deep water in the Pacific and Atlantic Oceans.

Remarks.—The figures given by d'Orbigny in his 1846 monograph show a test of very finely arenaceous material. The figures and descriptions given by the other authors vary slightly in detail, possibly because of the different materials used in the arenaceous test.

Genus *Haplophragmoides* Cushman, 1910

Haplophragmoides obliquicameratus Marks, n. sp.

Plate 5, figures 1a-c

Test planispiral, both vertically and tangentially compressed, giving a very irregular appearance; almost involute, umbilical region strongly depressed, periphery subacutely rounded. Chambers rather few, eight to ten visible in the last whorl, gradually increasing in size as added, very slightly inflated, much higher than broad. Sutures straight, radiate, slightly depressed, wall arenaceous, consisting of fine sandy material, firmly cemented, surface smooth. Aperture a very narrow elongated slit at the base of the last-formed chamber on the ventral side of the test.

Diameter: 0.35 to 0.49 mm; thickness 0.20 to 0.29 mm.

Remarks.—The test at first sight has the appearance of a normal trochoid test which has been subjected to a lateral shearing stress. Although it first appeared to be a pathological case, numerous similar paratype specimens have been found.

Occurrence.—Holotype from the Tortonian, at a depth of 240.8 meters, in a boring near Roth-Neusiedl, Austria.

Family TEXTULARIIDAE

Subfamily SPIROPLECTAMMININAE

Genus *Spiroplectammina* Cushman, 1927

Spiroplectammina carinata (d'Orbigny)

Plate 6, figures 2a, b

Textularia carinata D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 263; D'ORBIGNY, 1846, Foram. foss. Vienne, p. 247, pl. 14, figs. 32-34.

Textularia lacera REUSS, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 84, pl. 6, figs. 52, 53.

Textularia attenuata REUSS, Ibid., p. 84, pl. 6, fig. 54.

Test elongate, much compressed, gradually enlarging from the rounded initial end, early chambers arranged in a planispiral whorl, in the adult biserial; periphery acute, broadly keeled, often dentate. Chambers distinct, about twice as broad as high, regularly increasing in size as added. Sutures very distinct, oblique, slightly curved, broadly limbate. Wall arenaceous, smooth,

finely perforate. Aperture large, terminal, in the apertural face at the inner margin of the last-formed chamber, with a distinct lip.

Length: 0.35 to 1.77 mm; breadth: 0.31 to 0.87 mm; thickness: 0.17 to 0.39 mm.

Remarks.—The specimens vary considerably with respect to the peripheral characters, several having a straight, smooth keel, others a lobulate or even a dentate one, with all intermediate stages represented. The initial coil is usually visible only in the microspheric forms.

The specimens figured by Brady (Chall. Rep., vol. 9, 1884, p. 360, pl. 42, figs. 14-16) are actually *Textularia pseudocarinata* Cushman.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei, Sooss; Beethovenaussicht, Vienna; Vöslau, Breyersche Ziegelei, Baden and Roth-Neusiedl, all in the Vienna region. Reported from the Eocene to Miocene of western and central Europe.

Spiroplectammina deperdita (d'Orbigny)

Textularia deperdita D'ORBIGNY, 1846, Foram. foss. Vienne, p. 244, pl. 14, figs. 23-25.

Test elongate, much compressed, periphery acutely keeled, initial chambers close coiled, biserial in the adult, rapidly flaring from the rounded initial end; chambers numerous, $2\frac{1}{2}$ to three times as broad as high, regularly increasing in size as added. Sutures somewhat depressed, distinct, slightly curved, making only a slight angle with the horizontal. Wall arenaceous, perforate, smooth. Aperture a low, arched opening at the inner margin of the last-formed chamber.

Length: 0.45 to 0.82 mm; breadth: 0.35 to 0.60 mm; thickness: 0.25 to 0.33 mm.

Remarks.—*S. deperdita* somewhat resembles *S. pectinata* (Reuss), but lacks the strongly dentate keel and horizontal sutures of the latter.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei, Sooss, Beethovenaussicht, Vienna, the Breyersche Ziegelei, Vöslau and from Baden.

Spiroplectammina mariae (d'Orbigny)

Textularia mariae D'ORBIGNY, 1846, Foram. foss. Vienne, p. 246, pl. 14, figs. 29-31.

Textularia articulata D'ORBIGNY, Ibid., p. 250, pl. 15, figs. 16-18.

Plecanium mariae (d'Orbigny) var. *inermis* REUSS, 1867, Sitz. Akad. Wiss. Wien, vol. 55, p. 64, pl. 1, figs. 5-7.

Test elongate, compressed, initial part consisting of a planispiral whorl, at least in the microspheric form, quickly becoming biserial, periphery subacutely rounded, but with a narrow keel, often somewhat toothed. Chambers distinct, somewhat inflated, numerous, about twice as broad as high, gradually increasing in relative height

as added, sutures distinct, somewhat depressed, making an angle of about 20 degrees with the horizontal, straight. Wall arenaceous, smoothly finished, aperture a low, arched opening at the base of the last-formed chamber.

Length: 0.42 to 1.42 mm; breadth: 0.34 to 0.53 mm; thickness: 0.17 to 0.25 mm.

Remarks.—The keel passes through various stages of development, passing unbroken along the periphery in "*T. articulata*," in "*T. mariae*" forming a small spine on each chamber and with "*T. mariae* var. *inermis*" forming the intermediate stage. Often these variations may be observed on a single specimen.

Occurrence.—Specimens have been collected from the Stephansche Ziegelei, Sooss, and from Roth-Neusiedl. Reported from the Miocene of central Europe.

Spiroplectammina pectinata (Reuss)

Textularia pectinata REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 381, pl. 49, figs. 2, 3; 1867, Sitz. Akad. Wiss. Wien, vol. 55, p. 98, pl. 3, fig. 11.

Plecanium spinulosum REUSS, 1867, Ibid., p. 65, pl. 1, fig. 3.

Plecanium serratum REUSS, 1867, Ibid., p. 66, pl. 1, fig. 4.

Textularia pala CZJZEK, 1848, Haid. Nat. Abh., vol. 2, p. 148, pl. 13, figs. 25-27.

Test elongate, compressed, distinctly planispiral in the initial portion, quickly becoming biserial, flaring rapidly from the somewhat rounded initial end. Periphery acutely keeled, strongly lobulate; chambers ending in a short spine, numerous, distinct, about three times as broad as high, rapidly increasing in size as added. Sutures straight, strongly depressed, nearly horizontal, making an angle of a maximum of 10 degrees with the horizontal. Wall arenaceous, smoothly finished, finely perforate. Aperture a low arched opening at the base of the last-formed chamber.

Length: 0.45 to 1.10 mm; breadth: 0.35 to 0.63 mm; thickness: 0.18 to 0.33 mm.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei, Sooss, Beethovenaussicht, Vienna, Breyersche Ziegelei, Vöslau. Reported from the Pliocene of Italy.

Subfamily TEXTULARIINAE

Genus *Textularia* Defrance, 1824

Textularia mayeriana d'Orbigny

Textularia mayeriana D'ORBIGNY, 1846, Foram. foss. Vienne, p. 345, pl. 14, figs. 26-28.

Test elongate, not much compressed, rapidly flaring from the pointed initial end. Chambers numerous, much broader than high, increasing rapidly in size as added; sutures distinct, depressed, straight, making only a very slight angle with the horizontal. Periphery

subacute, wall arenaceous, smooth; aperture a low arched opening at the base of the last-formed chamber.

Length: 0.39 mm; breadth: 0.27 mm; thickness: 0.21 mm.

Occurrence.—Specimens have been obtained from the Beethovenaussicht, Vienna; Baden, Austria.

Genus *Siphotextularia* Finlay, 1939

Siphotextularia concava (Karrer)

Plecanium concavum KARRER, 1868, Sitz. Akad. Wiss. Wien, Vol. 58, p. 129, pl. 1, fig. 3.

Textularia concava (Karrer) BRADY, 1884, Challenger Rept., vol. 9, p. 360, pl. 43, fig. 11; CUSHMAN, 1911, U. S. Nat. Mus. Bull. 71, pt. 2, p. 22, figs. 38a, b; MILLET, 1899, Jour. Roy. Micr. Soc., p. 559, pl. 7, fig. 5.

Test elongate, biserial, regularly tapering to the pointed initial end, greatest breadth at the apertural end, rectangular in transverse section. Chambers broader than high, regularly increasing in size as added, sutures distinct, straight, becoming somewhat depressed in the adult stage, making an angle of about 20 degrees with the horizontal. Wall arenaceous, finely perforate. Aperture at the basal margin of the last-formed chamber, small, with an indistinct lip and short neck.

Length: 0.53 mm; breadth: 0.35 mm; thickness: 0.14 mm.

Occurrence.—One specimen has been obtained from the Miocene clay of the Beethovenaussicht, Vienna. Reported from the Miocene of Cuba (Palmer, 1940-1941, Mem. Soc. Cuba, vols. 14, 15), and living in the Atlantic Ocean.

Genus *Bigenerina* d'Orbigny, 1826

Bigenerina nodosaria d'Orbigny

Bigenerina nodosaria D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 261, no. 1, pl. 11, figs. 9-12.

Bigenerina agglutinans D'ORBIGNY, 1846, Foram. foss. Vienne, p. 238, pl. 14, figs. 8-10; BRADY, 1884, Challenger Rept., vol. 9, p. 369, pl. 44, figs. 14-18.

Test free, arenaceous, consisting of fine, sandy material; initial part biserial, compressed, consisting of about 12 chambers, sutures indistinct, slightly depressed, making an angle of about 20 degrees with the horizontal. Adult stage uniserial, chambers slightly inflated, about as high as broad, in the older part somewhat broader than high, circular in cross-section. Aperture terminal, simple, rounded.

Length: 0.84 to 0.87 mm; diameter 0.25 mm.

Remarks.—Our specimens seem to possess a somewhat finer arenaceous structure than those depicted by d'Orbigny in 1846 under the name *Bigenerina agglutinans*. As there are no essential differences in general

structure, however, there seems to be no reason to separate them.

Occurrence.—Specimens have been obtained from the clay of the Stephansche Ziegelei, Sooss, near Baden. Reported from the Miocene of central Europe and the Mediterranean regions and living in shallow water of most of the larger oceans.

Family VALVULINIDAE

Subfamily EGGERELLINAE

Genus *Karrerella* Cushman, 1933

Karrerella siphonella (Reuss)

Gaudryina siphonella REUSS, 1851, Zeitschr. deutsche. geol. Gesell., vol. 3, p. 78, pl. 5, figs. 40-42.

Karrerella siphonella (Reuss) CUSHMAN, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 34, pl. 4, figs. 3, 4; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 8, p. 125, pl. 14, figs. 27-32.

For adequate description and figures see papers by J. Cushman.

Length: 0.32 mm; diameter: 0.32 mm.

Remarks.—Only the initial trochoid parts have been found in our Vienna Basin material.

Occurrence.—Originally described from the Middle Oligocene of Germany, very rare specimens have been obtained from the clay of the Stephansche Ziegelei, Sooss, near Baden.

Genus *Martinottiella* Cushman, 1933

Martinottiella communis (d'Orbigny)

Clavulina communis D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 268, no. 4; 1846, Foram. foss. Vienne, p. 196, pl. 12, figs. 1, 2; BRADY, 1884, Challenger Rept., vol. 9, p. 394, pl. 48, figs. 3, 4, 7, 8, 13.

Martinottiella communis (d'Orbigny) CUSHMAN, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 37, pl. 4, figs. 6-8.

Length: 0.53 to 1.05 mm; diameter: 0.20 to 0.31 mm.

Occurrence.—Specimens have been obtained from Miocene clays of the Breyersche Ziegelei, Vöslau, Beethovenaussicht, Vienna and the Stephansche Ziegelei at Sooss, near Baden. Reported from the Eocene of southern France, Oligocene Septaria clay of Germany, Miocene of central Europe, Pliocene of Italy, and Recent cosmopolitan in shallow water (Brady).

Family MILIOLIDAE

Genus *Articulina* d'Orbigny, 1826

Articulina sulcata Reuss var. *nuda* Marks, n. var.

Plate 5, figures 8a-c

Test oval in outline, somewhat compressed, periphery rounded, chambers broadly developed, arranged in a

quineloculine series, inflated. Sutures distinct, depressed. Wall calcareous, imperforate, smooth or very indistinctly ornamented with longitudinal striae. Aperture large, irregularly oval, with distinct lip, without tooth. The lip remains visible between the two last-formed chambers.

Length: 0.32 to 0.42 mm; breadth: 0.25 to 0.35 mm; thickness: 0.18 to 0.19 mm.

Remarks.—The variety differs from the original species described by Reuss (Denkschr. k. k. Akad. Wiss. Wien, vol. 1, 1850, p. 389, pl. 49, figs. 13-17) in lacking the distinct longitudinal striae with which Reuss' form is depicted. This species has been assigned to the genus *Articulina*, because of its apertural features, although no additional uniserial row of chambers, characteristic for this genus, has yet been found, either by Reuss or by the present writer.

Occurrence.—Specimens have been obtained from the Ziegelei near Heiligenstadt, Austria. No other localities are reported.

Genus *Quineloculina* d'Orbigny, 1826

Quineloculina agglutinans d'Orbigny

Quineloculina agglutinans d'ORBIGNY, 1839, Foram. Cuba, p. 168, pl. 12, figs. 11-13; BRADY, 1884, Challenger Rept., vol. 9, p. 180, pl. 8, figs. 6, 7; CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 22, pl. 1, figs. 1a-c.

Test elongate, slightly depressed, somewhat tapering at both ends. Chambers indistinct, somewhat inflated; sutures hardly visible. Wall calcareous, imperforate, covered with an outer layer of rather coarse sandy material. Aperture distinct, rounded, comparatively small, terminal, with bifid tooth.

Length: 0.42 to 0.69 mm; diameter: 0.20 to 0.35 mm.

Remarks.—The internal structure is discernible only after sectioning, as the arenaceous coating completely obliterates the sutures.

Occurrence.—Specimens have been obtained from samples from the Beethovenaussicht, Vienna, Austria. Reported living, widely distributed (Brady).

Quineloculina akneriana d'Orbigny

Quineloculina akneriana d'ORBIGNY, 1846, Foram. foss. Vienne, p. 290, pl. 18, figs. 16-21.

Quineloculina triangularis d'ORBIGNY, Ibid., p. 288, pl. 18, figs. 7-9.

Quineloculina mayeriana d'ORBIGNY, Ibid., p. 287, pl. 18, figs. 1-3.

Quineloculina hauerina d'ORBIGNY, Ibid., p. 286, pl. 17, figs. 25-27.

Quineloculina regularis REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 384, pl. 50, fig. 1.

Quineloculina concinna REUSS, Ibid., p. 384, pl. 50, fig. 2.

Quineloculina impressa REUSS, 1851 Zeitschr. deutsche geol. Gesell., vol. 3, p. 87, pl. 7, figs. 5-9.

Quineloculina ernani BORNEMANN, 1855, Ibid., vol. 7, p. 353, pl. 19, fig. 6.

Quineloculina ovalis BORNEMANN, Ibid., p. 353, pl. 19, fig. 9.

Quineloculina seminula BRADY (non Linné), 1884, Challenger Rept., vol. 9, pl. 5, fig. 6; CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 24, pl. 2, figs. 1, 2.

Test somewhat longer than broad, greatest breadth about in the middle, chambers distinct, rather uniform in diameter, periphery rounded, sutures distinct, depressed; wall calcareous, imperforate, smooth. Aperture large, semicircular, tooth simple or absent.

Length: 0.50 to 1.31 mm; breadth: 0.40 to 0.67 mm; thickness: 0.30 to 0.42 mm.

Remarks.—*Quineloculina akneriana* is a most common species in both the Tertiary and Recent, is somewhat variable in relative dimensions, and has been described under quite a number of different names. Most of the modern authors have made it a synonym of *Q. seminula* (Linne), but as Thalmann has pointed out, Linnaeus never published an adequate figure for the recognition of this species.

Occurrence.—Specimens have been obtained from the Ziegelei Heiligenstadt, a railway cut near Vöslau, and the Stephansche Ziegelei, Sooss, near Baden.

Quineloculina auberiana d'Orbigny

Quineloculina auberiana d'ORBIGNY, 1839, Foram. Cuba, p. 167, pl. 12, figs. 1-3; BRADY, 1884, Challenger Rept., vol. 9, p. 162, pl. 5, figs. 8, 9.

Quineloculina ungeriana d'ORBIGNY, 1846, Foram. foss. Vienne, p. 291, pl. 18, figs. 22-24.

Quineloculina peregrina d'ORBIGNY, 1846, Ibid., p. 292, pl. 19, figs. 1-3.

Test short, stout, somewhat compressed, slightly longer than broad, chambers distinct, broadly developed; periphery acute, giving a somewhat triangular cross-section; wall calcareous, imperforate, smooth; aperture round, tooth simple.

Length: 0.87 mm; breadth: 0.70 mm; thickness 0.37 mm.

Remarks.—This form differs from *Q. lamarckiana* in the periphery being only acutely angled, and not strongly keeled, as is the latter. In all other respects they are very similar and it is possible that the difference is only varietal.

Occurrence.—Specimens have been obtained from the railway cut near Vöslau; the Stephansche Ziegelei, Sooss, near Baden.

Quinqueloculina boueana d'Orbigny

Quinqueloculina boueana d'ORBIGNY, 1846, Foram. foss. Vienne, p. 293, pl. 19, figs. 7-9.

Quinqueloculina nussdorfensis d'ORBIGNY, Ibid., p. 295, pl. 19, figs. 13-15.

Quinqueloculina zigzag d'ORBIGNY, Ibid., p. 295, pl. 19, figs. 16-18.

Test elongate in outline, compressed, chambers rather uniform in diameter. Sutures distinct, depressed. Wall thick, calcareous, imperforate, ornamented with irregular, strongly developed costae, running longitudinally. Aperture large, circular, with simple tooth.

Length: up to 1.40 mm; breadth: up to 0.69 mm; thickness: up to 0.42 mm.

Occurrence.—Specimens have been collected from the railway cut near Vöslau, and from Ziegelei Heiligenstadt.

Quinqueloculina longirostra d'Orbigny

Plate 5, figures 4a-6c

Quinqueloculina longirostra d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 303, no. 46; 1846, Foram. foss. Vienne, p. 291, pl. 18, figs. 25-27.

Adelosina laevigata d'ORBIGNY, 1826, op. cit., p. 304, no. 1; 1846, op. cit., p. 302, pl. 20, figs. 22-24; CUSHMAN, 1945, Cushman Lab. Foram. Res., Spec. Publ. 13, p. 8, pl. 1, figs. 1-8, pl. 3, figs. 1-3, p. 16.

Test elongate, compressed, periphery acutely keeled, chambers distinct, somewhat inflated, broadly developed; sutures distinct, depressed. Wall calcareous, smooth, imperforate. Aperture terminal, round, small, at the end of a somewhat elongate neck, with a simple tooth.

Length: 1.12 to 1.21 mm; breadth: 0.71 to 0.88 mm; thickness: 0.32 to 0.39 mm.

Remarks.—Early stages of this species often occur separately, thus forming the "genus" *Adelosina* d'Orbigny, with many different stages occurring, from the initial, single chambered, disklike carinate form to the full-grown quinqueloculina stage. This is one of the few forms represented by isolated prolocula, and these single, well-developed initial chambers may represent the megalospheric generation. Specimens have been found with only one additional chamber, added in a plane turned 90 degrees from that of the initial chamber, after which the development continues in the regular quinqueloculine fashion. This second chamber remains visible during a long period of development, on the side of the adult form.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei, Sooss. It is further reported from the Pliocene of Italy and the Recent of the Adriatic.

Quinqueloculina pygmaea Reuss

Quinqueloculina pygmaea REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 384, pl. 50, fig. 3.

Test small, elongate, compressed, somewhat tapering at both ends. Chambers narrow, rather uniform in diameter, distinct, slightly inflated. Sutures distinct, depressed. Wall calcareous, smooth, imperforate, with a glassy lustre. Aperture small, round, terminal, with a simple tooth.

Length: 0.29 to 0.39 mm; breadth: 0.11 to 0.17 mm; thickness: 0.10 to 0.14 mm.

Occurrence.—Specimens have been collected from the Beethovenaussicht, Vienna and from the Stephansche Ziegelei, Sooss, near Baden.

Quinqueloculina rugosa d'Orbigny

Quinqueloculina rugosa d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 302; FORNASINI, 1905, Mem. Accad. Sc. Inst. Bologna, ser. 6, vol. 2, p. 66, pl. 3, fig. 13; CUSHMAN, 1945, Cushman Lab. Foram. Res., Spec. Publ. 13, p. 16, pl. 2, fig. 15, pl. 4, fig. 4.

Quinqueloculina contorta d'ORBIGNY, 1846, Foram. foss. Vienne, p. 298, pl. 20, figs. 4-6.

Quinqueloculina juleana d'ORBIGNY, Ibid., p. 298, pl. 20, figs. 1-3.

Quinqueloculina rodolphina d'ORBIGNY, Ibid., p. 299, pl. 20, figs. 7-9.

Quinqueloculina badenensis d'ORBIGNY, Ibid., p. 299, pl. 20, figs. 10-12.

Quinqueloculina mariae d'ORBIGNY, Ibid., p. 300, pl. 20, figs. 13-15.

Test ovate, longer than broad, compressed, uniform in breadth, rectangular in cross-section, periphery subacute. Wall calcareous, thick, imperforate, rather coarse. Aperture large, rounded, with simple tooth.

Length: 0.66 to 1.76 mm; breadth: 0.45 to 0.88 mm; thickness: 0.32 to 0.52 mm.

Occurrence.—Specimens have been obtained from the Ziegelei Heiligenstadt and the railway cut near Vöslau.

Genus Sigmoilina Schlumberger, 1887**Sigmoilina tenuis** (Czjzek)

Plate 5, figure 7

Quinqueloculina tenuis CZJZEK, 1847, Haid. Nat. Abh., vol. 2, p. 149, pl. 13, figs. 31-34; REUSS, 1850, Denkschr., k. Akad. Wiss. Wien, vol. 1, p. 385, pl. 1, fig. 8; REUSS, Zeitschr. deutsche geol. Gesell., vol. 3, p. 87, pl. 7, fig. 60.

Spiroloculina tenuissima REUSS, 1867, Sitz. Akad. Wiss. Wien, vol. 55, p. 71, pl. 1, fig. 11; BRADY, 1884, Challenger Rept., vol. 9, p. 152, pl. 10, figs. 7, 8, 11.

Sigmoilina tenuis (Czjzek) CUSHMAN, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 4, p. 81, pl. 12, figs. 12-14.

Test ovate in outline, strongly depressed, quinqueloculine in the initial portion, with four to six chambers following in annular series, added in planes turned more than 180 degrees from one another, so as to form

a slight spiral. Chambers very narrow, elongate, wall calcareous, imperforate, very smooth. Sutures distinct, depressed. Aperture small, circular, terminal, somewhat projecting, with a simple tooth.

Length: 0.42 mm to 0.52 mm; breadth: 0.17 to 0.30 mm; thickness 0.10 to 0.12 mm.

Remarks.—Brady has published several transverse sections in which the sigmoid character is distinctly visible. Our specimens have a more slender build than is shown in the figures of Cushman.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei, Sooss, near Baden, the Ziegelei Heiligenstadt, and from the Beethovenaussicht in Vienna. Reported from the Miocene of North and South America, from California, Ecuador and Venezuela.

Genus *Nummuloculina* Steinmann, 1881

Nummuloculina contraria (d'Orbigny)

Biloculina contraria D'ORBIGNY, 1846, Foram. foss. Vienne, p. 266, pl. 16, figs. 4-6; REUSS, 1867, Sitz. Akad. Wiss. Wien, vol. 55, p. 54, pl. 1, fig. 10; KARRER, 1868, Ibid., vol. 58, p. 132.

Planispirina contraria (d'Orbigny) BRADY, 1884, Challenger Rept., vol. 9, p. 195, pl. 11, figs. 10, 11.

Nummuloculina contraria (d'Orbigny) STEINMANN, 1881, Neues Jahrbuch, p. 31, pl. 2; CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 45, pl. 10, fig. 1.

Test circular in outline, compressed, initial stage quinqueloculine, later chambers in planispiral whorls, three chambers to the last whorl. Sutures indistinct, slightly depressed, umbilical region inflated, raised, wall calcareous, imperforate, smooth. Aperture semicircular, with a broad flat tooth. Periphery rounded.

Diameter: 0.24 mm; thickness: 0.19 mm.

Remarks.—The generic characters were first defined by Steinmann, who showed that this form differed from *Planispirina* by its quinqueloculine initial stage. D'Orbigny first referred this species to *Biloculina* (*Pyrgo*), as the outward features bear a slight resemblance to that genus.

Occurrence.—Found only from the clay from the Stephansche Ziegelei at Sooss, near Baden. Reported as widespread in Recent deposits in the Atlantic and Pacific Oceans.

Genus *Triloculina* d'Orbigny, 1826

Triloculina consobrina d'Orbigny

Triloculina consobrina D'ORBIGNY, 1846, Foram. foss. Vienne, p. 277, pl. 18, figs. 10-12.

Test elongate-oval in outline, two chambers visible from one side, three from the other, periphery rounded. Chambers somewhat inflated, sutures distinct, depressed. Wall calcareous, imperforate, smooth. Aperture terminal, round, with a slender bifid tooth.

Length: 0.35 to 0.45 mm; breadth: 0.25 to 0.31 mm; thickness: 0.22 mm.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei, Sooss, near Baden.

Triloculina decipiens REUSS

Triloculina decipiens REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 382, pl. 49, fig. 8.

Test circular in outline, little if at all compressed, almost triangular in transverse section, periphery broadly rounded. Chambers inflated, last chamber somewhat enveloping the preceding ones, aperture large, semicircular, with slight lip and simple, flattened tooth.

Length: 0.49 to 0.52 mm; breadth: 0.52 mm; thickness: 0.35 mm to 0.39 mm.

Remarks.—*T. decipiens* shows some affinity to *T. subrotunda* (Montagu) from which it differs in having the distinct tooth, which does not occur in *T. subrotunda*.

Occurrence.—Specimens have been obtained from the railway cut near Vöslau.

Triloculina nitens REUSS

Triloculina nitens REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 383, pl. 49, fig. 10.

Test elongate, two to 2½ times as long as broad, two chambers visible on one side, three on the other. Sutures distinct, very slightly depressed, wall calcareous, imperforate, smooth, with typical vitreous lustre. Aperture small, round, terminal, with slender bifid tooth.

Length: 0.43 to 0.69 mm; breadth: 0.23 to 0.31 mm; thickness: 0.17-0.19 mm.

Occurrence.—Specimens have been obtained from the Ziegelei Heiligenstadt, the Beethovenaussicht, Vienna and from Wiesen.

Triloculina subrotunda (Montagu)

Vermiculum subrotundum MONTAGU, 1803, Test. Britt., pt. 2, p. 521.

Quinqueloculina subrotunda (Montagu) D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 302, no. 36.

Triloculina truncata KARRER, 1865, Sitz. Akad. Wiss. Wien, vol. 50, p. 704, pl. 1, fig. 2.

Triloculina dilatata KARRER, 1868, Ibid., vol. 58, p. 139, pl. 2, fig. 1.

Miliolina circularis BORNEMANN, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 349, pl. 19, fig. 4.

Triloculina circularis (Bornemann) CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 58, pl. 13, figs. 6, 7, pl. 14, figs. 1, 2.

Test rounded, slightly compressed, periphery broadly rounded, sutures distinctly depressed. Chambers dis-

unct, inflated, last chamber somewhat embracing. Wall calcareous, smooth, imperforate. Aperture large, semi-circular, with distinct lip, without tooth in our specimens.

Length: 0.35 mm; breadth: 0.32 mm; thickness: 0.17 mm.

Remarks.—Specimens are very often corroded or pyritized, which makes identification difficult. The dimensions of our specimens do not agree very well with those given by Cushman for *T. circularis* Bornemann, but the figures given by Brady for *T. circularis* are quite similar to our specimens. These figures of Brady were assigned by Thalmann to *T. subrotunda*.

Occurrence.—Ziegelei at Heiligenstadt. Reported from the Oligocene of Germany, and living in shallow water of tropical and temperate regions.

Triloculina trigonula (Lamarck)

Miliolites trigonula LAMARCK, 1804, Ann. Mus., vol. 5, p. 351, no. 3.

Miliolites cor-anguinum LAMARCK, Ibid., p. 351, no. 2.

Triloculina trigonula (Lamarck) d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 299, pl. 16, figs. 5-9; PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 33, pl. 1, fig. 7; BRADY, 1884, Challenger Rept., vol. 9, p. 164, pl. 3, figs. 15, 16.

Triloculina austriaca d'ORBIGNY, 1846, Foram. foss. Vienne, p. 275, pl. 16, figs. 25-27.

Triloculina gibba d'ORBIGNY, 1846, Ibid., p. 274, pl. 16, figs. 22-24; REUSS, 1865, Sitz. Akad. Wiss. Wien, vol. 50, p. 450, pl. 1, fig. 4; CUSHMAN, 1945, Cushman Lab. Foram. Res., Spec. Publ. 13, p. 26, pl. 3, fig. 10, pl. 6, fig. 11.

Miliola austriaca EGGER, 1857, Neues Jahrbuch, p. 271, pl. 6, figs. 4-6.

Test ovate in outline, regularly triloculine, sub-triangular in transverse section, periphery rounded. Chambers distinct, inflated, sutures slightly depressed. Oldest exposed chamber often exposed only slightly, wall calcareous, imperforate, smooth, aperture rounded, terminal, with a simple tooth.

Length: 0.68 to 0.82 mm; diameter: 0.45 to 0.70 mm.

Remarks.—*T. gibba* seems to form an intermediate stage between *T. trigonula* and *T. tricarinata*. As the latter has a distinctly carinate periphery and the original figure of d'Orbigny shows a rounded periphery for *T. gibba*, the latter is probably identical with *T. trigonula*, rather than *T. tricarinata*, as has been proposed by Brady.

Occurrence.—Specimens have been obtained from the railway cut near Vöslau. The species has been reported from the Tertiary throughout Europe, and Recent in shallow water of temperate zones.

Genus *Flintina* Cushman, 1921

Flintina droogeri Marks, n. sp.

Plate 5, figures 2a-3c

Test strongly compressed, initial stage triloculine, then quinqueloculine; loosely coiled in the adult, chambers distinct, three to a coil in the adult. Periphery broadly rounded; sutures distinct, depressed, except in the initial portion of the test where they are quite indistinct. Aperture large, semicircular, with slight lip and distinct bifid tooth. Wall calcareous, imperforate, smooth.

Length: 0.52 to 0.63 mm; breadth: 0.45 to 0.53 mm; thickness 0.18 to 0.28 mm.

Remarks.—This species has been named in honor of Mr. C. W. Drooger, micro-paleontologist at the state University of Utrecht.

Occurrence.—Specimens have been collected from the locality at Ulrichskirchen, near Baden, Austria.

Genus *Pyrgo* Defrance, 1804

Pyrgo bulloides (d'Orbigny)

Biloculina bulloides d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 297, pl. 16, figs. 1-4.

Biloculina clypeata d'ORBIGNY, 1846, Foram. foss. Vienne, p. 263, pl. 15, figs. 19-21.

Biloculina simplex d'ORBIGNY, 1846, Ibid., p. 246, pl. 15, figs. 25-27.

Biloculina turgida REUSS, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 85, pl. 7, fig. 55.

Biloculina ringens PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 35, pl. 1, fig. 3.

Biloculina caudata BORNEMANN, 1855, Zeitschr. deutsche geol. Gesell., vol. 7, p. 348, pl. 19, fig. 2.

Test subglobular, oval in outline, periphery rounded, only the last two chambers visible, the younger embracing the former on one side. Chambers inflated, arranged in annular series. Aperture large, milioline, with large, indistinctly bifid tooth. Wall calcareous, smooth, imperforate, sometimes forming two blunt projections on the aboral side.

Length: 0.34 to 0.70 mm; breadth: 0.23 to 0.61 mm; thickness: 0.24 to 0.57 mm.

Remarks.—The specimens described by Brady (Challenger Rept., 1884, p. 142, pl. 2, figs. 5, 6) have been determined by Thalmann to be assignable to *Pyrgo lucernula* (Schwager). It is possible that the species referred by Lamarck (Ann. Mus. 1804, vol. 5, p. 351) to *Miliolina ringens* and by Defrance (Dict. des Sci. Nat., 1816) to *Pyrgo laevis* are actually the same as the present species, being the most common type of *Pyrgo* in this region, but no adequate figures have been given by the above mentioned authors.

Occurrence.—Specimens have been obtained from

the Ziegelei Heiligenstadt, Austria. Reported from the Oligocene and Miocene of Germany and central and western Europe.

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus *Robulus* Montfort, 1808

Robulus ariminensis (d'Orbigny)

Robulina ariminensis D'ORBIGNY, 1846, Foram. foss. Vienne, p. 95, pl. 4, figs. 8, 9.

Test planispiral, involute, close-coiled, compressed, six chambers visible in the last whorl, periphery acutely keeled. Chambers not very distinct, gradually increasing in size as added, very slightly inflated. Sutures distinct, very slightly depressed. Aperture radiate, at the top of the last-formed chamber, with a small slit extending into the apertural face. Wall finely perforate, ornamented with four to five well-developed, plate like costae, running parallel to the periphery.

Length: Up to 1.25 mm.

Remarks.—This species shows some affinity with *R. costatus* (Fichtel and Moll), although the authors do not give a very distinct figure.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei, Sooss.

Robulus clericii (Fornasini)

Cristellaria clericii FORNASINI, 1901, Mem. R. Accad. Sci. Bologna, ser. 5, vol. 9, p. 65, pl. 1, fig. 17; CUSH-

MAN, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 4, p. 84, pl. 12, figs. 16, 17; NUTTALL, 1928, Quart. Jour. Geol. Soc., vol. 84, p. 87, pl. 5, fig. 10.

Test planispiral, involute, compressed, close-coiled, seven to nine chambers in the last whorl, periphery subacute. Chambers distinct, regularly increasing in size as added. Sutures distinct, limbate, very strongly curved, up to 90 degrees, flush with the surface. Wall calcareous, smooth, finely perforate. Apertural face triangular, aperture terminal, radiate, with small slit extending down the apertural face.

Diameter: up to 0.70 mm; thickness: up to 0.40 mm.

Remarks.—The figures given by Reuss (Denkschr. k. k. Akad. Wiss., 1850, vol. 1, p. 369, pl. 46, fig. 18) of a *Robulus*, which he referred to *Robulina obtusa*, possibly indicate a species identical with the present species. Reuss' figure is not sufficiently distinct, however, to warrant such a conclusion.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei at Sooss, Austria. Reported from the Miocene of Italy, Venezuela, Trinidad and Ecuador.

Robulus clericii (Fornasini)

var. *carinata* Marks, n. var.

Plate 5, figures 9a-b

The variety differs from the original in having a very narrow, sharp keel and is generally smaller in size.

Diameter: 0.39 to 0.52 mm; thickness 0.18 to 0.28 mm.

EXPLANATION OF PLATE 5

| FIGS. | | PAGE |
|----------|--|------|
| 1a-c. | <i>Haplophragmoides obliquicameratus</i> Marks, n. sp. Miocene, Roth-Neusiedl, Vienna Basin. 1a, dorsal view of holotype; 1b, ventral view; 1c, apertural view, all $\times 37$. | 35 |
| 2a-3c. | <i>Flintina droogeri</i> Marks, n. sp. Miocene, Ulrichskirchen, Vienna Basin. 2a, side view of holotype; 2b, peripheral view; 3a, 3b, side views of paratype; 3c, apertural view. All $\times 37$. | 41 |
| 4a-6c. | <i>Quinqueloculina longirostra</i> d'Orbigny. Miocene, Stephansche Ziegelei, Sooss, near Baden, Vienna Basin. 4a, side view of initial chamber; 4b, peripheral view; 5a, initial chamber with second chamber added in side view; 5b, reverse side of same; 6a, 6b, lateral views of adult specimen; 6c, peripheral view. All figures $\times 27$. | 39 |
| 7. | <i>Sigmulina tenuis</i> (Czjzek). Miocene, Beethovenaussicht, Vienna. Side view, $\times 37$. | 39 |
| 8a-c. | <i>Articulina sulcata</i> Reuss, var. <i>nuda</i> Marks, n. var. Miocene, Ziegelei Heiligenstadt, Vienna Basin. 8a, 8b, lateral views of holotype; 8c, peripheral view. All $\times 33$. | 37 |
| 9a, b. | <i>Robulus clericii</i> (Fornasini) var. <i>carinata</i> Marks, n. var. Miocene, Stephansche Ziegelei, Sooss, near Baden, Vienna Basin. 9a, Side view of holotype; 9b, apertural view, $\times 37$. | 42 |
| 10a-11b. | <i>Marginulinopsis pedum</i> (d'Orbigny) Miocene, Stephansche Ziegelei, Sooss, near Baden, Vienna Basin. 10a, side view of initial stage; 10b, peripheral view; 11a, side view of adult specimen; 11b, peripheral view. All $\times 27$. | 44 |
| 12a, b. | <i>Marginulina rugoso-costata</i> d'Orbigny. Miocene, Stephansche Ziegelei, Sooss, near Baden, Vienna Basin. 12a, Side view; 12b, peripheral view, $\times 27$. | 44 |
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Marks, Vienna Basin Miocene Foraminifera



Marks, Vienna Basin Miocene Foraminifera

Occurrence.—Holotype from the Stephansche Ziegelei, Sooss, Austria.

***Robulus intermedius* (d'Orbigny)**

Plate 5, figures 14a, b

Robulina intermedia d'ORBIGNY, 1846, Foram. Foss. Vienna, p. 104, pl. 5, figs. 3, 4.

Robulina inornata d'ORBIGNY, Ibid., p. 102, pl. 4, figs. 25, 26.

Test planispirally coiled, compressed, involute, six chambers visible in the last whorl. Chambers distinct, gradually increasing in size as added, apertural face triangular, aperture radiate, terminal, extending with a small slit into the apertural face. Periphery varying from acute to distinctly keeled. Sutures distinct, limbate, very oblique but straight, flush with the surface. Umbilical region filled with a central disk of clear shell material.

Diameter: 0.60 to 1.10 mm; thickness: 0.36 to 0.60 mm.

Remarks.—The species is extremely variable in its characters, *R. inornata* without doubt being one of the variations. Possibly *R. simplex* d'Orbigny (1846, op. cit., p. 103, pl. 4, figs. 27, 28) may also be considered identical, as are *R. subangulata* and *R. nitida*, both described by Reuss in 1850.

Occurrence.—Specimens have been obtained from the localities at the railway cut near Vöslau and from the Stephansche Ziegelei, Sooss.

Genus *Marginulina* d'Orbigny, 1826

***Marginulina costata* (Batsch)**

Nautilus costatus BATSCH, 1791, Conchylien des Seesandes, p. 2, pl. 1, figs. 1a-g.

Marginulina raphanus d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 184, pl. 10, figs. 7, 8; PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., vol. 16, p. 19, pl. 1, fig. 35.

Marginulina obliquistriata KARRER, 1861, Sitz. Akad. Wiss. Wien, vol. 44, p. 446, pl. 1, fig. 8.

Cristellaria (*Marginulina*) *striatocostata* REUSS, 1863, Ibid., vol. 46, p. 62, pl. 6, fig. 2.

Marginulina turgida REUSS, Ibid., p. 63, pl. 6, fig. 7; BRADY, 1884, Challenger Rept., vol. 9, p. 528, pl. 65, figs. 10, 13; CUSHMAN, 1931, Contr. Cushman Lab. Foram. Res., vol. 7, pt. 3, p. 64, pl. 8, figs. 2-4.

Test planispiral in the initial part, uniserial in the adult, elongate, somewhat compressed, chambers distinct, not inflated, broader than high. Sutures indistinct, somewhat oblique, wall calcareous, perforate, ornamented with numerous, strong, longitudinal costae, tending to run somewhat spirally around the test. Aperture terminal, radiate, at the inner margin of the last-formed chamber.

Diameter 0.45 mm.

Remarks.—Only a fragmentary specimen has been obtained, so that it is impossible to definitely determine whether it should be assigned to *Marginulina costata* or to *Marginulinopsis densi-costata* Thalmann, 1937.

Occurrence.—Obtained in the Stephansche Ziegelei, Sooss. Reported from Liassic to Recent, very widespread, according to Brady.

***Marginulina glabra* d'Orbigny**

Marginulina glabra d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 259, mod. 55; PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 27, pl. 1, fig. 36; BRADY, 1884, Challenger Rept., vol. 9, p. 527, pl. 65, figs. 5, 6.

EXPLANATION OF PLATE 6

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Test elongate, quickly enlarging from the initial end, which is slightly planispirally coiled. Adult uniserial, chambers somewhat inflated, sutures oblique, slightly depressed, wall calcareous, smooth, finely perforate. Aperture terminal, radiate, at the inner margin of the last-formed chamber.

Length: up to 0.60 mm; diameter up to 0.24 mm.

Occurrence.—Specimens have been obtained from the Stephansche Ziegelei at Sooss, Austria. Reported from the Oligocene and Miocene of Central and Mediterranean Europe.

***Marginulina glabra* d'Orbigny var. *obesa* Cushman**

Marginulina glabra d'Orbigny, CUSHMAN, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 79, pl. 23, fig. 3.

Marginulina glabra d'Orbigny, var. *obesa* CUSHMAN, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 128, pl. 37, fig. 1.

Test close coiled in the initial portion, chambers small, adult stage uniserial, chambers inflated, circular in transverse section, sutures depressed, somewhat oblique. The coiled section of the test forms only a small portion of the whole, giving an impression of being only somewhat rounded at the base. Wall calcareous, finely perforate, smooth, somewhat translucent. Aperture with a short neck, radiate, at the inner margin of the last formed chamber.

Length: 0.66 mm; diameter: 0.28 mm.

Remarks.—Our specimen coincides well with the figures of Cushman, in his reports on the Recent Foraminifera from the Atlantic and Pacific Oceans.

Occurrence.—Stephansche Ziegelei, at Sooss, Austria.

***Marginulina hirsuta* d'Orbigny**

Plate 5, figure 13

Marginulina hirsuta d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 259; 1846, Foram. foss. Vienne, p. 69, pl. 3, figs. 15, 16.

Test elongate, initial portion close coiled, rapidly becoming uniserial in the adult, circular in transverse section. Chambers distinct, somewhat inflated, sutures depressed, somewhat oblique. Wall calcareous, finely perforate, somewhat translucent, ornamented with numerous irregularly placed, blunt spines. Aperture radiate, at the inner margin of the last formed chamber.

Length: 1.00 mm; diameter 0.25 mm.

Remarks.—According to Cushman (1948, Foraminifera, their classification and economic use, p. 53) this form is one of the trimorphic series ranging from *Marginulina hirsuta* d'Orbigny to *Nodosaria aculeata* d'Orbigny. Our topotype specimens show, however, many distinctly marginuline characters, such as the excentric placement of the aperture. Furthermore the initial portion is not loosely coiled as is shown in d'Or-

bigny's figures, but although only slightly, is nevertheless rather closely coiled.

Occurrence.—Stephansche Ziegelei at Sooss.

***Marginulina rugoso-costata* d'Orbigny**

Plate 5, figures 12a, b

Marginulina rugoso-costata d'ORBIGNY, 1846, Foram. foss. Vienne, p. 70, pl. 3, figs. 19-21.

Test elongate, initial portion close-coiled, chambers spreading fan-like, gradually increasing in size as added. Lower portion of the test slightly compressed, rounded to circular in transverse section in the uniserial adult stage. Chambers inflated, less so in the coiled portion. Sutures rather distinct, depressed. Wall calcareous, perforate, ornamented with numerous strongly developed, plate-like costae, somewhat oblique in the initial part of the test and ending in strong spines, straight in the upper part, but ending abruptly at the base of each chamber. Aperture terminal, radiate, on a neck.

Remarks.—The original figure of d'Orbigny shows a specimen with beautifully curved, very regular costae. It is probable, however, that this is a somewhat idealized illustration of a species somewhat difficult to depict. The topotype specimen with numerous, strongly developed costae may with strong probability be assigned to the species.

Occurrence.—Railway cut near Vöslau, the Stephansche Ziegelei at Sooss, and from a boring near Baden.

Genus *Marginulinopsis* Silvestri, 1904

***Marginulinopsis pedum* (d'Orbigny)**

Plate 5, figures 10a-11b

Marginulina pedum d'ORBIGNY, 1846, Foram. foss. Vienne, p. 68, pl. 3, figs. 13, 14.

Cristellaria lituiformis REUSS, 1863, Sitz. Akad. Wiss. Wien, vol. 48, p. 51, pl. 4, figs. 50a, b.

Test elongate, initial portion close coiled, robuline, consisting of a whorl of about four chambers, becoming uniserial in the adult. Initial part somewhat compressed, with the adult circular in transverse section. Chambers distinct, inflated, about as broad as high in the uniserial portion, triangular in the spiral part. Sutures distinct, depressed, straight. Wall calcareous, perforate, translucent, smooth. Aperture radiate, with a short neck, terminal. Periphery in the coiled part sub-acute, becoming broadly rounded in the adult.

Length: 0.45 to 1.20 mm; diameter: 0.30 to 0.40 mm (diameter through last formed chamber).

Remarks.—The early coiled portion may be found separately and has sometimes been mistaken for *Lenticulina*. Comparison with adult forms shows them to be only the initial robuline part of *Marginulinopsis*.

Occurrence.—Stephansche Ziegelei and from Baden, Austria. Also reported from the Oligocene of Germany.

Genus *Dentalina* d'Orbigny, 1826*Dentalina bifurcata* d'Orbigny

Dentalina bifurcata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 56, pl. 2, figs. 38, 39; REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 367, pl. 46, fig. 10; REUSS, 1865, Sitz. Akad. Wiss. Wien, vol. 50, p. 465; REUSS, 1867, Ibid., vol. 55, p. 82.

Test slender, elongate, consisting of a uniserial row of chambers, very gradually tapering from the initial end, very slightly curved. Chambers somewhat higher than broad, slightly inflated, gradually increasing in size as added. Wall calcareous, finely perforate, ornamented with numerous, distinct, longitudinal costae, breaking off at the sutures, often diverging fork-like, sometimes new costae appear by intercalation halfway up the chamber. Sutures straight, distinct, depressed. Aperture radiate, terminal.

Only fragmentary material has been observed. Diameter: 0.35 mm.

Occurrence.—Stephansche Ziegelei, Sooss, Austria.

Dentalina communis d'Orbigny

Dentalina communis D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 254, no. 35.

Dentalina ferstliana CZJZEK, 1847, Haid. Nat. Abh., vol. 2, p. 140, pl. 12, figs. 13-19.

Dentalina inornata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 44, pl. 1, figs. 50, 51; REUSS, 1863, Sitz. Akad. Wiss. Wien, vol. 48, p. 45, pl. 2, fig. 18.

Dentalina botscheri REUSS, Ibid., p. 44, pl. 2, fig. 17.

Dentalina ferstliana REUSS, BRADY, 1884, Challenger Rept., vol. 9, p. 504, pl. 62, figs. 19-22.

Test uniserial, gradually tapering from the initial end, slightly curved. Chambers distinct, somewhat broader than high in the older part, higher than broad in the younger part, circular in cross section. Sutures distinct, flush with the surface in the lower part, depressed in the younger portion, oblique. Wall smooth, calcareous, finely perforate, aperture terminal, radiate.

Length: 1.17 to 1.90 mm; diameter: 0.22 to 0.35 mm.

Remarks.—Quite a number of forms, described from many different localities and under various names, may be considered identical with this species. It is possible, however, that some of these forms may have different origins, showing convergence to the very simplest form of dentaline structure.

Occurrence.—Stephansche Ziegelei, Sooss. Reported from Cretaceous to Recent, cosmopolitan.

Dentalina cf. *scabra* Reuss

Dentalina scabra REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 367, pl. 46, figs. 7, 8.

Test uniserial, chambers subglobular, inflated, grad-

ually increasing in size as added. Sutures distinct, depressed, straight. Wall calcareous, finely perforate, ornamented with numerous longitudinal costae, which are well developed and plate-like, tending to be broken up into numerous spines and smaller segments. Aperture radiate, at the end of a slender neck.

Only fragmentary material has been observed.

Remarks.—The original figures of Reuss show a form with a simple rounded aperture, which would place it in the genus *Nodogenerina*. Our topotype material coincides quite well with respect to ornamentation and other features, but shows a distinctly radiate aperture, so that the assignment to the genus *Dentalina* seems to be correct.

Genus *Nodosaria* Lamarck, 1812*Nodosaria longiscata* d'Orbigny

Nodosaria longiscata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 32, pl. 1, figs. 10-12.

Nodosaria arundinea SCHWAGER, 1866, Novara Exped., Geol. Theil, vol. 2, pt. 1, p. 211, pl. 5, figs. 43-45; BARBAT and VON ESTORFF, 1933, Jour. Paleon., vol. 7, p. 169.

Test very slender, elongate, chambers cylindrical, strongly elongate, about 10 or more times as long as broad. Sutures distinct, straight, not depressed, but each succeeding chamber seems to be encircling the former. Aperture unknown because of damaged material. Wall calcareous, perforate, smooth.

Diameter: 0.17 to 0.20 mm.

Remarks.—Very probably the specimens depicted by Schwager are identical to those figured by d'Orbigny (1846) from the Vienna Basin. The sutures seem to be slightly more depressed, but otherwise there are no appreciable differences.

Kleinpell (Miocene of California) figures a specimen which should not be referred to *N. longiscata*, but which seems more to resemble a fragment of *D. boueana* d'Orbigny.

The apertural features are not distinct in our fragmentary material, nor are distinctly radiate apertures figured by the older authors. It is therefore possible that this species in reality belongs to the genus *Nodogenerina*.

Occurrence.—Stephansche Ziegelei, Sooss. Reported from Tertiary to Recent, from Europe and the Atlantic Ocean.

Nodosaria rudis d'Orbigny

Nodosaria rudis D'ORBIGNY, 1846, Foram. foss. Vienne, p. 33, pl. 11, figs. 17-19; GALLOWAY and MORREY, Jour. Paleon., vol. 5, no. 4, p. 338, pl. 38, fig. 2.

Test uniserial, quite slender, consisting of a varying number of chambers. Chambers subglobular, inflated, initial chamber often larger than later ones, chambers increasing very gradually in size as added. Sutures

strongly constricted, often leaving only a tubular connection between the chambers. Wall calcareous, finely perforate, more or less roughly cancellated, sometimes smooth. Aperture with a long cylindrical neck, distinctly radiate.

Length: up to 1.40 mm; diameter: 0.20 to 0.34 mm.

Remarks.—In outward appearance the species is more like a *Siphonodosaria* or a *Nodogenerina*, because of its often larger initial chamber, long cylindrical neck and chambers of almost uniform size. However, as the aperture is distinctly radiate, the species must be placed in the genus *Nodosaria*.

Occurrence.—Stephansche Ziegelei, Sooss, Austria. Reported from the Cretaceous of Mexico (Galloway and Morrey).

Subfamily LAGENINAE

Genus *Lagena* Walker and Jacob, 1798

Lagena hexagona (Williamson)

Entosolenia squamosa var. *hexagona* WILLIAMSON, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 20, pl. 2, fig. 23.

Lagena favosa REUSS, 1862, Sitz. Akad. Wiss. Wien, vol. 46, p. 334, pl. 5, figs. 72, 73.

Lagena geometrica REUSS, Ibid., p. 334, pl. 5, fig. 74.

Lagena hexagona (Williamson) BRADY, 1884, Challenger Rept., vol. 9, p. 472, pl. 58, figs. 32, 33; CUSHMAN, 1929, Contr. Cushman Lab. For. Res., vol. 5, pt. 3, p. 72, pl. 11, fig. 8.

Length: 0.30 mm; diameter: 0.20 mm.

Remarks.—It seems doubtful that this species actually belongs to the family Lagenidae, as the aperture is only simple rounded and not radiate. Probably a number of these so-called "*Lagena*" should be placed with *Entosolenia*, although an internal tube is rarely discernible.

It is also difficult to draw a line between *Lagena hexagona* and *L. squamosa*, particularly the var. *scalariformis*, as the ornamentation often tends to intergrade.

Occurrence.—Stephansche Ziegelei, Sooss. Reported from numerous localities, widely scattered in both Tertiary and Recent.

Lagena vulgaris Williamson

Lagena vulgaris WILLIAMSON, 1850, Recent For. Britain; REUSS, 1863, Sitz. Akad. Wiss. Wien, vol. 46, p. 321, pl. 1, fig. 15, pl. 2, figs. 16, 17; CUSHMAN, 1944, Contr. Cushman Lab. For. Res., vol. 20, pt. 4, p. 89, pl. 13, fig. 26.

Length: 0.23 mm; diameter: 0.10 mm.

Occurrence.—Beethovenaussicht, Vienna. Reported from the Oligocene of Germany, Pliocene of Belgium and England, and Recent, very cosmopolitan.

Lagena vulgaris Williamson var. *semistriata* (Williamson)

Lagena striata var. *semistriata* WILLIAMSON, 1848, Ann. Mag. Nat. Hist., vol. 1, p. 14, pl. 1, figs. 9, 10.

Lagena vulgaris var. *semistriata* (Williamson) WILLIAMSON, 1850, Recent For. Britain, p. 6, pl. 1, fig. 9; REUSS, 1863, Sitz. Akad. Wiss. Wien, vol. 46, p. 322, pl. 2, figs. 18, 21; BRADY, 1884, Challenger Rept., vol. 9, p. 465, pl. 57, figs. 14, 16, 17.

Oolina lacrima BORNEMANN, 1855, Zeitschr. deutsche geol. Gesell., vol. 7, p. 307, pl. 12, fig. 2.

Oolina tenuis BORNEMANN, Ibid., p. 307, pl. 12, fig. 3.

Oolina punctata EGGER, 1857, Neues Jahrbuch, p. 268, pl. 5, figs. 1, 2.

Oolina striatula EGGER, Ibid., p. 269, pl. 5, figs. 3-8.

Length: 0.30 mm; diameter: 0.20 mm.

Remarks.—Our specimens resemble most closely *L. lacrima* (Bornemann), *L. striatula* (Egger) and *L. vulgaris* var. *semistriata* (Williamson), as figured by Reuss in his 1863 monograph. These species are certainly identical; the other synonyms above were figured with somewhat stronger and slightly fewer costae.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, and from Baden, Austria; reported from numerous Tertiary and Recent localities.

Lagena striata (d'Orbigny)

Oolina striata D'ORBIGNY, 1839, For. Amer. Mer., p. 21, pl. 5, fig. 12.

Oolina haidingeri CZJZEK, 1847, Haid. Nat. Abh., vol. 2, p. 138, pl. 12, figs. 1, 2.

Lagena haidingeri (Czjzek) REUSS, 1863, Sitz. Akad. Wiss. Wien, vol. 46, p. 326, pl. 3, fig. 4.

Lagena gracilicosta REUSS, Ibid., p. 327, pl. 3, figs. 42, 43.

Lagena striata (d'Orbigny) REUSS, Ibid., p. 327, pl. 3, figs. 44, 45; pl. 4, figs. 46, 47; BRADY, 1884, Challenger Rept., vol. 9, p. 460, pl. 57, figs. 22-24; CUSHMAN, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 19, pl. 17, figs. 4, 5.

Diameter: 0.28 mm.

Remarks.—Our specimen has the finely punctate base figured by d'Orbigny and Czjzek. Both Reuss and Brady figure their specimens with a highly ornamented tubular neck, however. It is difficult to determine whether this feature, so striking in many Lagenids, should be considered a specific distinction.

Occurrence.—Stephansche Ziegelei, Sooss. Reported as cosmopolitan from Tertiary to Recent.

Family POLYMORPHINIDAE

Subfamily POLYMORPHININAE

Genus *Guttulina* d'Orbigny, 1826

Guttulina austriaca d'Orbigny

Guttulina austriaca D'ORBIGNY, 1846, For. foss. Vi-

enne, p. 223, pl. 12, figs. 23-25; CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., p. 29, pl. 4, figs. 3-5.

Polymorphina oblonga D'ORBIGNY, 1846, Foram. foss. Vienne, p. 232, pl. 12, figs. 29-31; BRADY, 1884, Challenger Rept., vol. 9, p. 569, pl. 73, fig. 4.

Test elongate, oval, rounded in transverse section. Chambers elongate, slightly embracing, arranged in rather irregular clock-wise series, each succeeding chamber farther removed from the base. Sutures depressed, distinct, wall smooth, finely perforate. Aperture terminal, radiate.

Length: 0.73 mm; diameter: 0.45 mm.

Remarks.—Because of the chamber arrangement, *G. austriaca* is easily mistaken for *G. problema*, but it differs in that the younger chamber does not reach quite to the base, leaving the proloculum distinct. By considering large series of the species from the topotype localities, Cushman and Ozawa found that this species gradually passes into *Polymorphina oblonga*, which forms the adult stage of *Guttulina austriaca*.

Occurrence.—Stephansche Ziegelei.

Guttulina irregularis (d'Orbigny)

Globulina irregularis D'ORBIGNY, 1846, Foram. foss. Vienne, p. 226, pl. 13, figs. 9, 10.

Guttulina communis D'ORBIGNY, Ibid., p. 224, pl. 13, figs. 6-8.

Guttulina problema D'ORBIGNY, Ibid., p. 224, pl. 12, figs. 26-28.

Guttulina dilatata REUSS, 1850, Denkschr. k. Akad. Wiss, Wien, vol. 1, p. 378, pl. 48, fig. 11.

Guttulina semiplanata REUSS, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 82, pl. 6, fig. 48.

Test oval in outline, with rounded edges except for the somewhat acute apertural end, triangular in section, with rounded angles. Chambers somewhat elongate, arrangement clockwise, embracing, generally reaching back to the base, except for one or two of the youngest chambers. Sutures distinct, only very slightly depressed, wall smooth, finely perforate. Aperture terminal, radiate.

Length: 0.45 to 0.49 mm; breadth: 0.35 to 0.36 mm; thickness: 0.27 to 0.31 mm.

Occurrence.—Beethovenaussicht, Vienna.

Genus *Globulina* d'Orbigny, 1826

Globulina gibba d'Orbigny

Globulina gibba D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 266, mod. 63; D'ORBIGNY, 1846, Foram. foss. Vienne, p. 227, pl. 13, figs. 13, 14; EGGER, 1857, Neues Jahrbuch, p. 289, pl. 13, figs. 1-4; CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., p. 60, pl. 16, figs. 1-4; TOULMIN, 1941, Jour. Paleon., vol. 15, p. 594, pl. 80, fig. 9.

Polymorphina gibba (d'Orbigny) PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 29, pl. 2, fig. 52; BRADY, 1884, Challenger Rept., vol. 9, p. 561, pl. 71, figs. 12a, b.

Test globular, circular in transverse section. Chambers few, somewhat inflated, embracing, arranged in a triserial series. Sutures distinct, flush with the surface; wall smooth, finely perforate. Aperture radiate, often somewhat projecting.

Length: 0.35 to 0.64 mm; diameter: 0.28 to 0.52 mm.

Occurrence.—Breyersche Ziegelei, Vöslau, Stephansche Ziegelei, Sooss, and the Beethovenaussicht, Vienna. Recorded from Eocene to Pliocene as cosmopolitan. Recent from the Mediterranean and the Irish Sea.

Genus *Glandulina* d'Orbigny, 1826

Glandulina laevigata d'Orbigny

Glandulina laevigata D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 252, no. 1, pl. 10, figs. 1-3; D'ORBIGNY, 1846, Foram. foss. Vienne, pl. 1, figs. 4-5; CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., p. 43, pl. 40, fig. 1; CUSHMAN and LAI-MING, 1931, Jour. Paleon., vol. 5, no. 2, p. 103, pl. 11, fig. 8.

Test ovate in outline, fusiform, circular in transverse section, initial end bluntly rounded in the megalospheric form, acutely pointed with a short spine in the microspheric form. Chambers biserially arranged in the early portion, changing abruptly into a uniserial arrangement, with the last formed chamber comprising a large portion of the test. In the megalospheric form the biserial stage is less prominent. Aperture terminal, radiate. Wall smooth, finely perforate.

Length: 0.35 to 0.55 mm; diameter: 0.24 to 0.42 mm.

Occurrence.—Breyersche Ziegelei, Vöslau. Recorded from the Pliocene of Italy.

Family GLOBOROTALIIDAE

Genus *Globorotalia* Cushman, 1927

Globorotalia menardii (d'Orbigny)

Rotalia menardii D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 273, no. 6.

Rotalina boueana D'ORBIGNY, 1846, Foram. foss. Vienne, p. 152, pl. 7, figs. 25-27.

Pulvinulina menardii (Orbigny) PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 20, pl. 3, fig. 81; BRADY, 1884, Challenger Rept., vol. 9, p. 690, pl. 103, figs. 1, 2; CUSHMAN, 1915, U. S. Nat. Mus. Bull. 71, pt. 5, p. 54, pl. 22, fig. 32.

Pulvinulina tumida BRADY, 1884, Challenger Rept., vol. 9, p. 692, pl. 103, figs. 4-6; CUSHMAN, 1915, U. S. Nat. Mus. Bull. 71, pt. 5, p. 56, pl. 22, fig. 3.

Globorotalia menardii (d'Orbigny) KURT SCHMIDT, 1934, Eclogae geol. Helv., vol. 27, p. 45.

Length: 0.38 to 0.74 mm; breadth: 0.34 to 0.61 mm; thickness: 0.17 to 0.32 mm.

Remarks.—*Rotalina boueana* d'Orbigny, 1846, appears to be identical to the species under discussion. For further references and extensive discussion, see Schmidt (1934).

Occurrence.—Stephansche Ziegelei, Sooss, Breyersche Ziegelei, Vöslau, and from the Ziegelei Heiligenstadt. Reported as very widely distributed both in the Tertiary and Recent.

Family NONIONIDAE

Genus *Nonion* Montfort, 1808

Nonion boueanum (d'Orbigny)

Plate 5, figures 17a, b

Nonionina boueana d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 108, pl. 5, figs. 11, 12; BRADY, 1884, *Challenger Rept.*, vol. 9, p. 729, pl. 109, figs. 12, 13.

Nonion boueanum (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 12, pl. 3, figs. 7, 8.

Test planispirally coiled, much compressed, involute, chambers numerous, usually 11 to 13 visible, inflated very little, quite broad and low, increasing regularly in size as added. Sutures quite distinct, broadly limbate, slightly if at all depressed, strongly curved. Wall smooth, finely perforate, umbilical region depressed and filled with finely granulose matter. Periphery subacutely rounded. Aperture a low opening in the base of the apertural face.

Length: 0.39 to 0.52 mm; breadth: 0.34 to 0.39 mm; thickness: 0.18 to 0.25 mm.

Remarks.—Attempts to separate the species *Nonion scaphum*, *N. boueanum*, *N. commune* and *N. asterizans* have failed, because of the intergradation of several features, such as the number of chambers, the comparative length and breadth and the amount of granulose matter in the umbilical region. It might be rather interesting to determine from topotype specimens of the above-mentioned species, whether or not there is a definite relationship; statistical studies would be especially appropriate in this connection.

The specimens figured by Nuttall under this name (*Jour. Paleon.*, vol. 4, 1930, p. 284, pl. 23, figs. 11, 14) are not identical, and may be a species of *Anomalina*.

Occurrence.—Beethovenaussicht, Vienna, Breyersche Ziegelei, Vöslau, Ziegelei Heiligenstadt, Baden and Roth-Neusiedl. Reported from the Oligocene, Miocene and Pliocene of Germany, Austria and the Mediterranean regions. Recent, Adriatic (?) and Atlantic Ocean.

Nonion granosum (d'Orbigny)

Nonionina granosa d'ORBIGNY, 1826, *Ann. Sci. Nat.*, vol. 7, p. 294; d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 110, pl. 5, figs. 19, 20.

Nonion granosum (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 11, pl. 2, figs. 17, 18.

Test planispiral, close-coiled, nearly involute, compressed, periphery broadly rounded. Chambers distinct, nine to twelve in the adult coil, rather uniform in shape, gradually increasing in size as added, slightly inflated. Sutures distinct, somewhat limbate, very slightly depressed, slightly curved. Umbilical region somewhat depressed, filled or covered with granular shell material, which often extends for some distance along the sutures. Wall smooth, distinctly perforate. Aperture a low, broad opening at the base of the apertural face.

Diameter: 0.28 to 0.49 mm; thickness: 0.10 to 0.19 mm.

Remarks.—The figures given by Cushman are not very typical for the species as represented by topotype specimens. The figures of d'Orbigny (1846) are much closer to the topotypes in appearance.

Occurrence.—Beethovenaussicht, Vienna; the Stephansche Ziegelei, Sooss, from Wiesen and from the railway cut near Vöslau. Reported from the Oligocene to Pleistocene of central European and Mediterranean regions. Recent doubtful.

Nonion grateloupi (d'Orbigny)

Nonionina grateloupi d'ORBIGNY, 1826, *Ann. Sci. Nat.*, vol. 7, p. 294.

Nonion grateloupi (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 21, pl. 6, figs. 1-7.

Test close-coiled, planispiral, almost involute, much compressed, elongate oval, sides nearly parallel in peripheral view; periphery rounded. Chambers numerous, nine to eleven in the adult coil, rapidly increasing in size as added, especially in length. Sutures distinct, slightly if at all depressed. Wall thin, smooth, finely perforate. Aperture a narrow slit at the base of the last-formed chamber.

Length: 0.18 to 0.35 mm; breadth: 0.10 to 0.23 mm.

Occurrence.—Beethovenaussicht, Vienna. Reported from the Miocene of France, Florida and the West Indian region, also Recent, same region.

Nonion perforatum (d'Orbigny)

Plate 6, figures 4a, b

Nonionina perforata d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 110, pl. 5, figs. 17, 18.

Nonionina punctata d'ORBIGNY, *Ibid.*, p. 111, pl. 5, figs. 21, 22.

Nonion densepunctatum EGGER, 1857, *Neues Jahrbuch*, p. 299, pl. 14, figs. 22, 23; CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 14, pl. 3, fig. 14.

Nonion perforatum (d'Orbigny) CUSHMAN, *Ibid.*, p. 12, pl. 3, fig. 3.

Test close-coiled, involute, umbilical region depressed, sometimes ornamented with a few, small, rounded bosses; periphery broadly rounded. Chambers distinct, numerous, nine to ten in the adult coil, regularly increasing in size as added, slightly inflated. Sutures indistinct, slightly depressed, curved, not limbate. Wall calcareous, smooth, but rather coarsely perforate. Aperture a low arched opening at the base of the apertural face.

Diameter: 0.50 mm; thickness: 0.25 to 0.30 mm.

Remarks.—The only difference between *Nonion perforatum* and *Nonion punctatum* seems to be the size of the perforations. Also *N. densepunctatum* Egger shows no appreciable differences.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss. Reported from the Miocene of Central Europe, Egypt and the Pliocene of Italy.

Nonion pompilioides (Fichtel and Moll)

Nautilus pompilioides FICHTEL and MOLL, 1798, Test. Micr., p. 1, pl. 2, figs. a-c.

Nonionina umbilicata D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 293, pl. 15, figs. 10-12.

Nonionina soldanii D'ORBIGNY, 1846, Foram. foss. Vienne, p. 109, pl. 5, figs. 15, 16.

Nonion pompilioides (Fichtel and Moll) PARKER, JONES and BRADY, 1863, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 18, pl. 3, fig. 98; BRADY, 1884, Challenger Rept., vol. 9, p. 727, pl. 109, figs. 10, 11; CUSHMAN, 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 4, pl. 1, figs. 7-11, pl. 2, figs. 1, 2; CUSHMAN, 1946, Cushman Lab. Foram. Res., Spec. Publ. 17, p. 6, pl. 1, figs. 1, 2; CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 19, pl. 5, figs. 9-12.

Test almost circular, compressed, involute, periphery broadly rounded. Chambers numerous, usually 11 to the adult coil, rather uniform in shape, gradually increasing in size as added. Sutures distinct, limbate, very slightly depressed, straight and radiating from the deeply depressed umbilicus. Wall calcareous, thin, smooth, very distinctly perforate. Aperture a wide, low slit at the base of the last-formed chamber.

Diameter: 0.24 to 0.70 mm; thickness: 0.14 to 0.49 mm.

Remarks.—Our specimens are clearly identical with the specimen figured by d'Orbigny (1846) as *Nonion soldanii*, about which he remarked that it was very similar to his *Nonionina umbilicata* (1826). I consider the species to be the same, and both identical to *Nautilus pompilioides* Fichtel and Moll, 1798. Their original figure, re-illustrated by Cushman (1946) also shows 11 chambers to the last whorl. Although Cushman described the species in his 1914 and 1930 reports as having numerous chambers, he figured some specimens showing only six to eight chambers, which also

differ slightly in other respects from the original. It appears probable that these specimens should be assigned to another species. Another specimen, figured from the northeast coast of the United States by Cushman in his Atlantic Report, seems to be too narrow to be *N. pompilioides*, and resembles more closely *N. umbilicatus* (Montagu).

Specimens described by Galloway and Morrey (Jour. Paleon., vol. 5, no. 4, p. 341, pl. 38, fig. 10) from the Cretaceous of Mexico, seem also rather doubtfully this species.

Occurrence.—Beethovenaussicht, Vienna, the Stephansche Ziegelei, Sooss, the Breyersche Ziegelei, Vöslau, and from Baden. Reported from the Miocene of France and the Mediterranean regions, Recent from Atlantic, Pacific, Mediterranean and Adriatic.

Nonion scaphum (Fichtel and Moll)

Plate 5, figures 16a, b

Nautilus scapha FICHTEL and MOLL, 1798, Test. Micr., p. 105, pl. 19, figs. d-f.

Nonionina scapha (Fichtel and Moll) BRADY, 1884, Challenger Rept., vol. 9, p. 730, pl. 109, figs. 14, 15 (not fig. 16).

Nonionina communis D'ORBIGNY, 1846, Foram. foss. Vienne, p. 106, pl. 5, figs. 7, 8.

Nonion commune (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 10, pl. 3, fig. 2.

Nonion scaphum (Fichtel and Moll) CUSHMAN, Ibid., p. 20, pl. 5, figs. 18-21; CUSHMAN, 1946, Cushman Lab. Foram. Res., Spec. Publ. 17, p. 11, 14, pl. 3, figs. 7-10.

Test planispiral, somewhat evolute, oval in outline, periphery rounded. Chambers numerous, increasing in size as added, but increasing more rapidly in length than in breadth, inflated. Sutures distinct, not limbate, depressed, distinctly curved. Umbilical region usually filled with finely granulose matter. Wall smooth, finely perforate, except in the umbilical region. Aperture a narrow opening at the base of the apertural face.

Length: 0.62 to 0.80 mm; breadth: 0.45 to 0.56 mm; thickness: 0.35 to 0.45 mm.

Remarks.—There is a close relationship between *N. commune* and *N. scaphum* and it is very difficult in fact to make any separation, on the basis of the original figures or from topotype material. This was recognized by Parker, Jones and Brady (Phil. Trans., vol. 45, p. 404). Reuss (1865) assigned *N. commune* to *N. boueanum*, from which it differs however in that the latter has more limbate sutures, more numerous and narrower chambers, and a more subacute periphery. No specimens have been found by the present writer that are quite similar to the figure given by d'Orbigny, showing a subacute keel and a very elongate outline. As there seems to be no reason to separate *N. scaphum*

and *N. commune*, both are here included under the older name, *N. scaphum* (Fichtel and Moll).

N. elongatum (d'Orbigny) may belong to the same series, but possesses fewer chambers; *N. scaphum* as figured both by the original authors and by Cushman, has 13 chambers.

Occurrence.—Collected from the railway cut near Vöslau, the Beethovenaussicht in Vienna, the Stephansche Ziegelei at Sooss, the Ziegelei Heiligenstadt, and from the Breyersche Ziegelei, Vöslau. Reported from the Pliocene of Italy and the Mediterranean regions.

Nonion tuberculatum (d'Orbigny)

Plate 5, figures 15a, b

Nonionina tuberculata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 108, pl. 5, figs. 13, 14.

Nonionina subgranosa EGGER, 1857, Neues Jahrbuch, p. 299, pl. 14, figs. 16-18.

Nonion tuberculatum (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 13, pl. 3, figs. 12, 16, 17.

Test planispiral, close-coiled, compressed, periphery rounded, umbilical region filled with shell material, ornamented with numerous small bosses, slightly depressed. Chambers ten to the adult coil, rather uniform in shape, regularly increasing in size as added, very slightly inflated. Sutures distinct, slightly depressed, curved. Wall thin, smooth, translucent, finely but distinctly perforate. Aperture a small but low opening in the base of the apertural face.

Diameter: 0.49 mm; thickness: 0.24 mm.

Remarks.—The similarity to *N. granosum* is very striking; it seems doubtful that the two should be separated.

Occurrence.—Ziegelei Heiligenstadt. Reported from the Upper Oligocene, Miocene and Pliocene of central and southern Europe.

Nonion turgescens Cushman

Plate 6, figure 5

Nonion turgescens CUSHMAN, 1936, Contr. Cushman Lab. Foram. Res., vol. 12, p. 64, pl. 12, figs. 2a, b; CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 10, pl. 2, fig. 14.

Test planispiral, close-coiled, almost involute, much compressed, with distinctly rounded, central umbonate boss. Periphery subacutely keeled, chambers very distinct, numerous, up to 13 in the adult coil with a raised inflated area near the center. Sutures very distinct, depressed, somewhat sigmoid. Aperture a low arched opening at the base of the apertural face. Wall thin, smooth, translucent, very finely perforate.

Diameter: 0.35 to 0.46 mm; thickness: 0.15 to 0.23 mm.

Remarks.—This species is very similar to *Nonion laevis* (d'Orbigny), but differs in that the keel is present over the whole of the test in *N. turgescens*, while *N. laevis* becomes broadly rounded in the adult.

Occurrence.—Sarmatian of Wiesen. Originally from the Oligocene of the Mainzer Basin.

Genus *Astrononion* Cushman and Edwards, 1937

Astrononion italicum Cushman and Edwards

Plate 6, figures 3a, b

Astrononion italicum CUSHMAN and EDWARDS, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 1, p. 35, pl. 3, figs. 19, 20; CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 37, pl. 10, figs. 13, 14.

Test planispiral, nearly involute, somewhat compressed, umbilicate, periphery slightly lobulate, broadly rounded. Chambers distinct, of rather uniform size and shape, very gradually increasing in size as added, eleven visible in the adult coil. Sutures distinct, somewhat limbate, curved, very slightly if at all depressed, in the younger stage more so than in the adult. Supplementary chambers very elongate, almost tubular. Aperture a very low slit at the base of the apertural face; apertures of the supplementary chambers at the outer chamber extremities, very oblique.

Diameter: 0.23 to 0.38 mm; thickness: 0.10 to 0.18 mm.

Remarks.—This species bears a remarkable resemblance to *A. novo-zealandicum*, from which it differs only in the shape of the supplementary apertures, and to *A. stellare* (d'Orbigny), both as figured by Cushman in his monograph. The umbo in our specimen shows a small part of the underlying coil, which is not evident in the figures given by Cushman.

Occurrence.—Beethovenaussicht, Vienna, and Baden. Reported from the Pliocene of Italy.

Genus *Elphidium* Montfort, 1808

Elphidium aculeatum (d'Orbigny)

Plate 6, figures 11a, b

Polystomella aculeata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 131, pl. 6, figs. 27, 28.

Elphidium aculeatum (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 44, pl. 11, fig. 16.

Test planispiral, involute, much compressed, periphery acutely keeled, with small spines, usually one to a chamber or less, somewhat irregularly scattered. Chambers distinct, numerous, 17 to 20 in an adult coil, increasing very slowly in size as added. Sutures distinct, depressed, gently curved, retral processes numerous, about 12 in the adult chambers. Aperture a series of openings at the base of the last-formed chamber.

Diameter: 0.52 to 0.61 mm; thickness: 0.23 mm.

Occurrence.—The Ziegelei Heiligenstadt and the Stephansche Ziegelei, Sooss. Reported from the Miocene of central Europe, southern Russia and the Pliocene of Italy and the Mediterranean region.

Elphidium advenum Cushman

Plate 6, figures 9-10b

Polystomella subnodosa BRADY, (not von Munster), 1884, Challenger Rept., vol. 9, p. 734, pl. 110, fig. 1.
Elphidium advenum CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 60, pl. 16, figs. 31-35.

Test planispiral, nearly involute, much compressed, periphery acute to subacute, narrowly keeled, slightly lobulate, especially in the last-formed portion. Chambers distinct, about 15 in the adult coil, slightly inflated, sutures depressed, distinct, very slightly curved or nearly radiate. Retral processes numerous, comparatively short, extending to about one fourth of the chamber. Umbilical region depressed, mostly filled with a small boss of clear shell material. Wall thin, smooth, translucent. Aperture consists of a number of small openings at the base of the apertural face.

Diameter: 0.35 to 0.63 mm; thickness: 0.17 to 0.28 mm.

Remarks.—*Elphidium advenum* is intermediate between *E. ungeri* (Reuss) at the one extreme and *E. flexuosum* on the other. Both in the size of the umbonate disc and in the number of chambers, it seems to represent a transitional stage. *E. advenum* has never previously been described from the Vienna Basin, although it is not rare in our material.

Occurrence.—From the Sarmatian of Wiesen and the Tortonian of the Ziegelei Heiligenstadt. Reported from the Miocene of Cuba, Recent from the Atlantic shore of the eastern United States and from several Pacific stations.

Elphidium antoninum (d'Orbigny)

Polystomella antonina d'ORBIGNY, 1846, Foram. foss. Vienne, p. 128, pl. 6, figs. 17-18.

Elphidium antoninum (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 43, pl. 11, fig. 14.

Test somewhat compressed, umbilical region depressed, sometimes with small bosses of shell material; periphery broadly rounded, slightly lobulate; chambers distinct, inflated, of uniform shape and with little increase in size as added, about 12 in the adult coil; sutures distinct, slightly depressed, somewhat curved, retiral processes rather short, about ten to the adult chamber, wall smooth and polished, except for the retiral processes; aperture a low opening at the base of the last-formed chamber, often subdivided.

Diameter: 0.35 mm; thickness: 0.14 mm.

Remarks.—Our single specimen does not agree too closely with the original figures of d'Orbigny. It is

fairly similar however, to the topotype figured by Cushman in his monograph on the Nonionidae.

Occurrence.—The Beethovenaussicht, Vienna. Rare.

Elphidium crispum (Linnaeus)

Nautilus crispus LINNE, 1758, Syst. Nat., 10 ed., p. 709; FICHTEL and MOLL, 1798, Test. Micr., p. 40, pl. 4, figs. a-f.

Polystomella crispa d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 283, no. 1, mod. 45; d'ORBIGNY, 1846, Foram. foss. Vienne, p. 125, pl. 6, figs. 9-14; BRADY, 1884, Challenger Rept., vol. 9, p. 736, pl. 110, figs. 6, 7.

Elphidium crispum (Linne) CUSHMAN, 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 20; CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 50, pl. 13, figs. 17-21; CUSHMAN, 1946, Cushman Lab. Foram. Res., Spec. Publ. 17, p. 7, pl. 1, figs. 11, 12.

Test planispiral, completely involute, lenticular in shape, the umbilical region covered or filled with a slightly projecting boss of shell material, the surface of which is covered with ten to twelve shallow pits; periphery subacute, angular, slightly keeled, often becoming lobular in the latter portion. Chambers numerous, up to 30 in our specimen, very long and narrow; sutures distinct, curved, depressed, retiral processes numerous, extending almost to the side of the next chamber, leaving pores along the chambers. Wall smooth, aperture a row of small openings at the base of the apertural face, set between the retiral processes. Apertural face low, sides often concave.

Diameter: up to 1.07 mm in our specimen; thickness up to 0.55 mm.

Occurrence.—Collected from the *Amphistegina* marls, Beethovenaussicht, Vienna. Reported from the Miocene and Pliocene of central and southern Europe, Recent in Mediterranean and Indo-Pacific regions.

Elphidium cryptostomum (Egger)

Plate 6, figures 8a, b

Polystomella cryptostoma EGGER, 1857, Neues Jahrbuch, p. 301, pl. 9, figs. 19, 20.

Elphidium cryptostomum (Egger) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 45, pl. 11, fig. 22.

Test planispiral, close coiled, compressed, nearly involute, periphery subacute in the early part, becoming more rounded in the adult. Umbilical region slightly depressed, filled with small bosses of clear shell matter. Chambers numerous, usually 12 in the adult, inflated, very gradually increasing in size as added. Sutures distinct, depressed, curved, retiral processes about nine to an adult chamber, only very slightly developed. Wall smooth, except for the umbonate part. Aperture a very

low opening at the base of the last formed chamber, often subdivided.

Diameter: 0.36 mm; thickness: 0.21 mm.

Remarks.—The figures given by Egger and Cushman do not show the somewhat granulose umbo, which is so evident in the specimen described from our collection. Our specimen does possess the very typical concave sides which are distinctly visible on the holotype and topotype figures.

Occurrence.—The Tortonian, Ziegelei Heiligenstadt. Rare. Reported from the Miocene of southern Germany.

Elphidium fichtelianum (d'Orbigny)

Plate 6, figures 12a, b

Polystomella fichteliana d'ORBIGNY, 1846, Foram. foss.

Vienne, p. 125, pl. 6, figs. 7, 8.

Elphidium fichtelianum (d'Orbigny) CUSHMAN, 1939,

U. S. Geol. Surv. Prof. Paper 191, p. 42, pl. 11, fig. 12.

Test planispiral, close coiled, not quite involute, strongly compressed. Periphery subacute, almost keeled. Chambers numerous, 16 to 18 in the adult coil, narrow, very gradually increasing in size as added, sutures depressed, distinct, strongly curved, retrol processes numerous, about 12 in the adult chamber, extending across nearly the whole of the chamber, wall strongly reticulate because of the retrol processes, aperture a narrow slit at the base of the last formed chamber, often subdivided into a row of small openings.

Diameter: 0.42 to 0.72 mm; thickness: 0.12 to 0.16 mm.

Occurrence.—The Beethovenaussicht, Vienna. Reported from the Miocene of central Europe, Pliocene of southern Europe, and Recent, Mediterranean.

Elphidium flexuosum (d'Orbigny)

Polystomella flexuosa d'ORBIGNY, 1846, Foram. foss.

Vienne, p. 127, pl. 6, figs. 15, 16.

Elphidium flexuosum (d'Orbigny) CUSHMAN, 1939,

U. S. Geol. Surv. Prof. Paper 191, p. 43, pl. 11, fig. 13.

Test strongly involute, compressed, umbilical region occupied by a disc of shell matter, periphery broadly rounded. Chambers distinct, numerous, 17 to 20 in the adult coil, slightly inflated, very gradually increasing in size as added. Sutures distinct, depressed, slightly curved, retrol processes numerous, distinct, short, extending over as much as one-half of the chambers, about 10 to an adult chamber. Wall very smooth except for the retrol processes. Aperture consists of a number of small openings at the base of the last formed chamber.

Diameter: 0.65 to 0.95 mm; thickness: 0.35 to 0.49 mm.

Occurrence.—Collected from Vöslau, Stephansche

Ziegelei, Sooss and the Ziegelei Heiligenstadt. Reported from the Miocene of central and southern Europe, Pliocene of Italy and Recent, Mediterranean.

Elphidium flexuosum (d'Orbigny)

var. *reussi* Marks, n. var.

Plate 6, figures 7a, b

Polystomella flexuosa REUSS (non d'Orbigny), 1850,

Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 370, pl. 48, figs. 3a, b.

The variety differs from the original in having fewer chambers, 12 to 14 to an adult coil, a narrower keel, shorter retrol processes, up to one-third the breadth of the adult chamber, and a distinctly projecting central boss, which in the original species is flush with the surface.

Diameter: 0.28 to 0.44 mm; thickness: 0.14 to 0.22 mm.

Occurrence.—From Beethovenaussicht, Vienna. Rather common.

Elphidium hauerinum (d'Orbigny)

Polystomella hauerina d'ORBIGNY, 1846, Foram. foss.

Vienne, p. 122, pl. 6, figs. 1, 2.

Elphidium hauerinum (d'Orbigny) CUSHMAN, 1939,

U. S. Geol. Surv. Prof. Paper 191, p. 42, pl. 11, fig. 9.

Test planispiral, compressed, involute, periphery broadly rounded, umbilical region slightly depressed. Chambers distinct, about 11 in the adult coil, slightly inflated, sutures distinct, depressed, somewhat curved, retrol processes extending to one half of the adult chamber, about five to six on an adult chamber. Wall smooth and polished, except for the sutures and retrol processes. Aperture consists of a number of small openings at the base of the apertural face.

Diameter: 0.42 mm; thickness: 0.27 mm.

Remarks.—The original figure of d'Orbigny shows slightly better developed retrol processes than is shown by the figures given by Cushman or by the topotype specimen of our collection.

Occurrence.—The Ziegelei Heiligenstadt.

Elphidium josephinum (d'Orbigny)

Polystomella josephina d'ORBIGNY, 1846, Foram. foss.

Vienne, p. 130, pl. 6, figs. 25, 26; EGGER, 1857, Neues Jahrbuch, p. 303, pl. 15, figs. 10, 11.

Elphidium josephinum (d'Orbigny) CUSHMAN, 1939,

U. S. Geol. Surv. Prof. Paper 191, p. 43, pl. 11, fig. 15.

Test planispiral, much compressed, involute; periphery acute. Chambers distinct, slightly inflated, each with a projecting peripheral angle and a short (occasionally rather long) spine, about eight to 14 chambers in the adult coil, increasing very gradually in size as added. Sutures distinct, depressed, slightly curved,

retral processes distinct, extending across the whole of the depressed area, about eight to an adult chamber. Wall smooth, except for the retral processes, aperture consisting of several openings at the base of the apertural face.

Diameter: 0.33 to 0.42 mm; thickness: 0.14 mm.

Remarks.—Cushman figured some specimens with rather short spines; long spined individuals are generally much more common in our material.

Occurrence.—From the Sarmatian (shallow to brackish water facies) of Wiesen.

Elphidium macellum (Fichtel and Moll)

Nautilus macellus FICHTEL and MOLL, 1798, Test. Micr., p. 66, var. a: pl. 10, figs. e-g; var. b: pl. 10, figs. h-k.

Elphidium macellum MONTFORT, 1808, Conch. syst., vol. 1, p. 15; CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 51, pl. 14, figs. 1-3, pl. 15, figs. 9, 10; CUSHMAN, 1946, Cushman Lab. Foram. Res., Spec. Publ. 17, p. 10, pl. 2, fig. 9.

Test planispiral, involute, lenticular, umbilical region flattened, slightly depressed; periphery subacute, slightly keeled, somewhat lobulate in the last-formed chambers; chambers numerous, eleven in the adult coil; sutures distinct, depressed, curved very strongly backwards toward the periphery, retral processes relatively long, about nine to the adult chamber. Wall calcareous, smooth except for the retral processes; aperture consists of a row of small openings at the base of the strongly convex apertural face.

Diameter: 0.56 mm; thickness: 0.28 mm.

Occurrence.—The Beethovenaussicht, Vienna, and the Ziegelei Heiligenstadt, Tortonian in age. Reported from the Mio-Pliocene of central and southern Europe.

Elphidium minutum (Reuss)

Platc 6, figures 6a, b

Polystomella minuta REUSS, 1864, Sitz. Akad. Wiss. Wien, vol. 50, pt. 1, p. 478, pl. 4, figs. 6a, b.

Polystomella discrepans REUSS, Ibid., p. 478, pl. 4, figs. 7a, b.

Elphidium minutum (Reuss) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 40, pl. 10, figs. 22-25.

Test planispiral, involute, compressed, periphery broadly rounded, sides flattened; chambers distinct, uniform in shape, very gradually increasing in size as added, eight to ten in the adult coil, only slightly inflated. Sutures distinct, somewhat depressed, curved, retral processes only faintly developed, about eight to the adult chamber. Aperture consisting of about six pores at the base of the apertural face. Wall smooth, thin, finely perforate.

Remarks.—Cushman (1939) figures a specimen as

having a central umbonate disc or boss. This feature has not been observed on our specimens, nor is it evident on the original figures of Reuss. The occurrence of a central umbonate disc does not appear to be a very distinctive character, however, as several species of the genus *Elphidium* possess this character in widely varying degree (e. g. *E. flexuosum*, *E. advenum*, etc.)

Occurrence.—The Tortonian of the Ziegelei Heiligenstadt. Reported from the Oligocene of Germany and Miocene of central Europe.

Elphidium reginum (d'Orbigny)

Polystomella regina D'ORBIGNY, 1846, Foram. foss. Vienne, p. 129, pl. 6, figs. 23, 24.

Elphidium reginum (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 44, pl. 11, fig. 19.

Test close-coiled, compressed, bi-umbonate, periphery subacute, with five relatively long spines independent of the chambers, length about equal to the radius of the test. Chambers distinct, numerous, eleven to the adult coil in our specimen, up to as many as 20, according to Cushman, gradually increasing in size as added. Sutures distinct, very slightly curved, nearly radial, retral processes distinct, reaching one-half to one-third the breadth of the chamber. Aperture consists of a number of small openings at the base of the apertural face. Wall smooth, finely perforate.

Diameter: 0.29 mm; thickness: 0.14 mm. Generally the specimens are much larger than this, especially from the Sarmatian, where according to Cushman, they may attain a size of 1.25 mm.

Occurrence.—The Tortonian, Ziegelei Heiligenstadt. Rare. Very typical for the Vienna Basin Miocene, no reports from any other locality.

Elphidium rugosum (d'Orbigny)

Polystomella rugosa D'ORBIGNY, 1846, Foram. foss. Vienne, p. 123, pl. 6, figs. 3, 4.

Polystomella obtusa D'ORBIGNY, Ibid., p. 124, pl. 6, figs. 5, 6.

Elphidium rugosum (d'Orbigny) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 42, pl. 11, figs. 10, 11.

Test nearly involute, compressed, periphery rounded, umbilical region flattened or slightly depressed, chambers numerous, about 12 to 17 to the adult coil, rather indistinct in our specimens, sutures indistinct, curved, retral processes well developed, leaving a reticulate design of rounded openings. Wall smooth, polished, finely perforate. Aperture a row of small openings at the base of the apertural face.

Diameter: 0.28 to 0.45 mm; thickness: 0.15 to 0.18 mm.

Remarks.—Both d'Orbigny and Cushman figure specimens with about 20 chambers to the adult coil, while in ours the number varies between 12 and 17. Cush-

man also figures 12 or more retral processes to the adult chamber, d'Orbigny figuring about eight. Our specimens show about seven retral processes to the adult chamber. In my opinion the typical characteristics of this species are the non-inflated chambers, the sutures which are discernible only by the rows of retral processes, and the rounded keel, although some specimens have been found with a subacute keel, also figured by Cushman.

Occurrence.—The Beethovenaussicht, Vienna. Miocene of central and southern Europe.

Elphidium ungeri (Reuss)

Polystomella ungeri REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 369, pl. 48, fig. 2.

Elphidium ungeri (Reuss) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Paper 191, p. 44, pl. 11, fig. 20.

Test planispiral, compressed, nearly involute, umbilicus small, slightly depressed, periphery sub-acute, slightly keeled. Chambers distinct, somewhat inflated, about 12 to the adult coil, very gradually increasing in size as added; sutures distinct, depressed, curved, retral processes relatively short, about seven to the adult chamber. Wall smooth, finely perforate. Aperture consists of a number of small openings at the base of the broadly triangular apertural face.

Diameter: 0.35 mm; thickness: 0.17 mm.

Remarks.—Although our specimen resembles very closely that figured by Cushman, the original figure of Reuss indicates a somewhat more angular periphery and shorter retral processes. Our specimen also shows a rather well developed keel.

Occurrence.—The Beethovenaussicht, Vienna and the Ziegelei Heiligenstadt. Reported from the Upper Oligocene of Germany, and Miocene of central and southern Europe.

Family HETEROHELICIDAE

Subfamily PLECTOFRONDICULARIINAE

Genus *Plectofrondicularia* Licbus, 1903

Plectofrondicularia digitalis (Neugeboren)

Plate 7, figure 4

Frondicularia digitalis NEUGEBOREN, 1850, Foram. von Felső-lapugy, art. 2, Verh. Mitt. Siebenb. Vedein fur Nat. Wiss. Jahrg. 1, no. 8, p. 121, pl. 3, figs. 4a, b, c.

Test elongate, compressed, initial stage planispiral, then biserial, and very soon becoming uniserial. Chambers numerous, about 20 in our (single) specimen, chevron-shaped in the uniserial part of the test. Sutures distinct, limbate, not depressed, oblique and becoming more strongly so towards the younger portion of the test. Wall finely perforate, ornamented with 10 strongly developed longitudinal costae, passing over nearly the whole of the test. One pair forms the lateral

periphery, closely flanked on each side by another pair, the broader sides of the test on each side ornamented by two, somewhat less well developed costae. Aperture rounded, simple, terminal.

Length: 1.16 mm; breadth: 0.25 mm; thickness: 0.08 mm.

Occurrence.—The Miocene (Tortonian) of the Stephansche Ziegelei, Sooss. Originally described from the Miocene of the Banat region, Hungary.

Genus *Amphimorphina* Neugeboren, 1850

Amphimorphina haueriana Neugeboren

Plate 7, figure 9

Amphimorphina haueriana NEUGEBOREN, 1850, Foram. von Felső-Lapugy, Verh. Mitt. Siebenb. Verein. fur Nat. Wiss., Jahrg. 1, no. 8, p. 125; KARRER, 1865, Sitz. k. Akad. Wiss. Wien, vol. 50, p. 705, pl. 1, fig. 6.

Test strongly elongate, regularly flaring from the initial portion. Initial part compressed, planispiral at first, at least in the microspheric form, then biserial, very soon becoming uniserial with chevron-shaped chambers. In the adult part of the test, the chambers rapidly attain a rounded cross section and a nodosarian development, becoming about as broad as high. Wall calcareous, finely perforate, ornamented in the initial part with three pairs of costae, one pair forming the lateral sides, flanked very closely on each side by another pair. In the adult, more costae appear by intercalation, up to a total of six pair of costae in the nodosarian part of the test. Costae generally well-developed, plate-like. Sutures distinct, limbate, flush with the surface in the initial part of the test, slightly depressed in the adult stage. Aperture round, simple, terminal.

Length: 1.05 to 2.25 mm; diameter: 0.17 to 0.30 mm.

Occurrence.—The Tortonian of the Stephansche Ziegelei, Sooss. Originally recorded from the Miocene of Hungary, reported only from the central European Miocene.

Subfamily EOUVIGERININAE

Genus *Nodogenerina* Cushman, 1927

Nodogenerina adolphina (d'Orbigny)

Dentalina adolphina D'ORBIGNY, Foram. foss. Vienne, p. 51, pl. 2, figs. 18-20; SCHWAGER, 1866, Novara Exp., Geol. Theil, vol. 2, p. 235, pl. 6, figs. 72, 73; SCHUBERT, 1911, Abh. k. geol. Reichsanst., vol. 20, pt. 4, p. 75, fig. 5; CUSHMAN, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 4, p. 86, pl. 13, figs. 3, 4. *Nodosaria lepidula* SCHWAGER, 1866, Novara Exp., Geol. Theil, vol. 2, p. 210, pl. 5, figs. 27, 28.

?*Ellipsonodosaria curvatura* CUSHMAN, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, pt. 3, p. 71, pl. 12, fig. 6.

Test slender, elongate, consisting of an uniserial row of inflated chambers, tapering gradually to the initial end. Chambers subglobular, gradually increasing in size as added, ornamented at the base with a row, or several rows of well developed, downward pointing spines. Sutures distinct, very strongly depressed, straight, in the adult part of the test often leaving only a tubular connection between the chambers. Wall calcareous, smooth, except for the base of the chambers, finely perforate. Aperture terminal, round, in many specimens with a cylindrical neck and phialine lip. One specimen shows the neck ornamented with spines.

Length: up to 1.75 mm; diameter: up to 0.24 mm.

Remarks.—Although most writers have considered this species as belonging to the genus *Dentalina*, it is at once clear from a study of the apertural characters that it cannot be placed in the family Lagenidae, as it lacks a radiate aperture. It should probably be placed in the genus *Nodogenerina* although it does not show the inflated initial chamber usually characteristic of this genus. As a matter of fact, we possess several specimens of *Nodosaria rudis* with a strongly inflated initial chamber, often surpassing in diameter the younger chambers, but with a distinctly radiate aperture so that we have considered it to belong to the Lagenidae. Taking only the apertural characteristics as a criterium, *Dentalina adolphina* and several other *Dentalinae* should be placed in the genus *Nodogenerina*, family Heteroheliceidae.

Occurrence.—The Stephansche Ziegelei, Sooss, and from Baden. Reported from the Miocene of California and Central America, Recent from the Atlantic Ocean.

Nodogenerina bradyi Cushman

Plate 7, figure 5

Sagrina virgula BRADY, 1884, Challenger Rept., vol. 9, p. 583, pl. 76, fig. 8.

Nodogenerina bradyi CUSHMAN, 1927, Contr. Cushman Lab. For. Res., vol. 2, pt. 4, p. 79.

Test slender, elongate, gradually tapering to the rounded initial end; chambers uniserially arranged, somewhat inflated, gradually increasing in size as added, widest at the base, lower portion rapidly constricted, forming a basal, finely spinose edge, at least in the adult part of the test. Wall calcareous, smooth, except for the basal portion of the chambers. In the lower part the spines are reduced to distinct costae. Aperture round, with a short neck and a distinct lip.

Length: 0.73 to 0.82 mm; diameter: 0.11 to 0.14 mm.

Occurrence.—The Stephansche Ziegelei, Sooss, Recent, cosmopolitan.

Nodogenerina consobrina (d'Orbigny)

Dentalina consobrina d'ORBIGNY, 1846, For. foss. Vienne, p. 46, pl. 2, figs. 1-3; BORNEMANN, 1855,

Zeitschr. deutsche geol. Gesell., vol. 7, p. 323, pl. 14, figs. 1-4; REUSS, 1863, Sitz. k. Akad. Wiss. Wien, vol. 48, p. 45, pl. 2, figs. 19-23; CUSHMAN, 1940, Contr. Cushman Lab. For. Res., vol. 16, pt. 4, p. 84, pl. 14, figs. 22-26.

Dentalina boueana d'ORBIGNY, 1846, For. foss. Vienne, p. 47, pl. 2, figs. 4-6.

Test uniserial, slender, gradually tapering to the initial end, chambers inflated, in the initial part about as broad as high, tending to become cylindrical in the adult, but varying greatly in relative height even in one individual. Initial end somewhat rounded, initial chamber often somewhat inflated. Wall calcareous, smooth, finely perforate. Aperture terminal, rounded, in well preserved specimens showing a cylindrical neck and a distinct lip.

Length: 0.68 to 2.10 mm; diameter: 0.10 to 0.21 mm.

Remarks.—The original type was figured by d'Orbigny as possessing an initial spine, which has not been observed in our specimens; otherwise there is little doubt that the two are identical. Reuss figures some specimens with the same general characteristics, but with a radiate aperture. It seems doubtful that this latter was actually observed. Our specimens distinctly show the neck and lip typical of *Nodogenerina*, no specimen having ever been observed with a radiate aperture.

Occurrence.—The Tortonian of the Stephansche Ziegelei, Sooss. Miocene of central Europe, ? America.

Nodogenerina elegans (d'Orbigny)

Dentalina elegans d'ORBIGNY, 1846, For. foss. Vienne, p. 45, pl. 1, figs. 52-56; KARRER, 1868, Sitz. k. Akad. Wiss. Wien, vol. 58, p. 162; REUSS, 1867, Ibid., vol. 55, p. 82.

Test uniserial, very slender, gradually tapering to the initial end. Chambers distinct, inflated, except in the younger part, somewhat higher than broad. Initial chamber inflated, with basal spine; sutures distinct, limbate, flush with the surface in the lower part, becoming more and more depressed in the later part. Wall calcareous, smooth, finely perforate. Aperture rounded, with neck, phialine lip and tooth.

Length: up to 2.45 mm; diameter: up to 0.35 mm.

Remarks.—Our specimens have been collected from the vicinity of the type locality and are therefore almost certainly identical with d'Orbigny's original type of *Dentalina elegans*. From the apertural features it is clear, however, that the species is not a *Dentalina*, but should be considered a *Nodogenerina*. The specimen figured by Schwager (Novara Exp.) should probably be referred to *Dentalina filiformis*.

Occurrence.—The Stephansche Ziegelei, Sooss, near Baden.

Nodogenerina hirsuta (Soldani)

Platc 7, figure 7

Nodosaria hirsuta (Soldani) d'ORBIGNY, 1826, Ann. Sci. Nat. vol. 7, p. 252.

Nodosaria hispida d'ORBIGNY, 1846, Foram. foss. Vienne, p. 35, pl. 1, figs. 24, 25; EGGER, 1895, Abh. k. Bayer. Akad. Wiss., vol. 18, p. 343, pl. 11, fig. 16; BRADY, 1884, Challenger Rept., vol. 9, p. 507, pl. 63, figs. 12-16; CUSHMAN, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 92, pl. 16, fig. 6.

Nodosaria aculeata d'ORBIGNY, 1846, Foram. foss. Vienne, p. 35, pl. 1, figs. 26, 27.

Dentalina floscula d'ORBIGNY, Ibid., p. 50, pl. 2, figs. 16, 17.

Nodosaria conspurcata REUSS, 1863, Sitz. k. Akad. Wiss. Wien, vol. 48, p. 43, pl. 2, figs. 10-12.

Test uniserial, straight, enlarging very slightly from the initial end, consisting of a row of four to seven chambers. Chambers inflated, sub-globular, initial chamber often larger than those following. Sutures strongly depressed, often leaving only a thin, tubular connection between the chambers, but sometimes only slightly depressed, both types occurring in one and the same specimen. Wall calcareous, finely perforate, ornamented with numerous well developed spines, occurring in longitudinal rows and giving the impression of broken up costae. Aperture terminal, with a cylindrical, ornamented neck and a more or less distinct lip.

Length: 0.77 to 1.22 mm; diameter: 0.17 to 0.30 mm.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, near Baden. Reported from the Recent, Atlantic Ocean.

Nodogenerina pauperata (d'Orbigny)

Platc 7, figure 6

Dentalina pauperata d'ORBIGNY, 1846, Foram. foss. Vienne, p. 46, pl. 1, figs. 5-7; BORNEMANN, 1855, Zeitschr. deutsche geol. Gesell. vol. 7, p. 321, pl. 13, fig. 7; CUSHMAN, 1940, Contr. Cushman Lab. Foram. Res., vol. 16, pt. 3, p. 58, pl. 10, fig. 15.

Dentalina inermis CZJZEK, 1848, Haidingers Nat. Abh., vol. 2, p. 139, pl. 12, figs. 3-7.

Ellipsonodosaria pauperata (d'Orbigny) KRECZI and LIEBUS, 1935, Neues Jahrb., vol. 74B, p. 125.

Test uniserial, slender, slightly curved, tapering slowly to the rounded initial portion. Chambers distinct, somewhat inflated in the adult, broader than high in the initial portion, becoming about as broad as high in the adult stage. Sutures distinct, flush with the surface in the initial part, in the adult becoming rather abruptly somewhat depressed. Wall calcareous, smooth, finely perforate. Aperture terminal, with a short neck and distinct lip.

Length: 0.70 to 0.80 mm; diameter: 0.14 to 0.19 mm.

Remarks.—*Nodogenerina pauperata* has been recorded several times in American literature, but the majority of these citations are erroneous. Cushman (Jour. Paleon., vol. 5, no. 2, p. 22, pl. 10, figs. 11, 12) figures specimens which are rather strongly flaring from the base, while topotypes of the present species have nearly parallel sides. Apart from this difference, many characteristic features do coincide, such as the simple aperture, the sutures flush with the surface in the initial portion with the chambers becoming inflated only in the adult stage. Cushman's form might therefore be accepted as a local variety of the type. But *Dentalina* cf. *pauperata* of Cushman and McMasters (Jour. Paleon., vol. 10, p. 511, pl. 75, figs. 1, 2) and of Cushman and LeRoy (Jour. Paleon., vol. 12, p. 124, pl. 22, fig. 16) are by no means identical with the original species, having a distinctly radiate aperture, and in the second case a distinctly inflated initial chamber.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss. Reported from the Miocene of central Europe.

Nodogenerina punctata (d'Orbigny)

Dentalina punctata d'ORBIGNY, 1846, Foram. foss. Vienne, p. 46, pl. 2, figs. 14, 15.

Test uniserial, gradually enlarging from the pointed initial end. Chambers inflated, gradually increasing in size as added, broader than high in the early part, gradually increasing in relative height to somewhat higher than broad in the adult. Sutures distinct, depressed, straight. Wall calcareous, perforate, coarsely punctate. Aperture large, rounded, terminal, with short neck and distinct lip.

Length: up to 0.87 mm; diameter: 0.15 to 0.27 mm.

Occurrence.—The Tortonian, Beethovenaussicht, Vienna.

Nodogenerina scripta (d'Orbigny)

Dentalina scripta d'ORBIGNY, 1846, Foram. foss. Vienne, p. 51, pl. 2, figs. 21, 23.

Dentalina perscripta EGGER, 1857, Neues Jahrb., p. 307, pl. 15, fig. 30.

Test uniserial, very slender, somewhat curved, gradually enlarging from the pointed initial end. Chambers inflated, about as broad as high in the early portion, gradually increasing in relative height as well as in diameter. Sutures distinct, depressed, straight. Wall thin, calcareous, somewhat translucent, finely perforate, ornamented with numerous very fine, longitudinal roughenings. Aperture terminal, round, with indistinct lip.

Length: up to 1.11 mm; diameter: up to 0.14 mm.

Occurrence.—The Tortonian, Stephansche Ziegelei, Sooss. Reported from the Miocene of southern Germany.

Family BULIMINIDAE

Subfamily BULIMININAE

Genus *Bulimina* d'Orbigny, 1826*Bulimina aculeata* d'Orbigny

Bulimina aculeata d'ORBIGNY, 1826. Ann. Sci. Nat., vol. 7, no. 7, p. 269; REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 874, pl. 47, fig. 13; BRADY, 1884, Challenger Rept., vol. 9, p. 406, pl. 51, figs. 7-9.

Test triserial, small, ovate, flaring rapidly from the base, about twice as long as broad, chambers inflated, increasing rapidly in size as added, arranged in a triserial series. Sutures distinct, depressed. Wall calcareous, thin, translucent, smooth, very finely perforate, the initial portion ornamented with a small number of well-defined spines. Aperture a loop-shaped slit in the apertural face, at the inner margin of the last-formed chamber.

Length: 0.41 mm; diameter: 0.19 mm.

Remarks.—Our single specimen is almost identical with that figured by Reuss from the Vienna Basin, which Cushman and Parker (1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 51) refer to the variety *subulata* of *Bulimina elongata* d'Orbigny. Actually, it would be very difficult to uphold this statement, *B. elongata* being relatively distinctly longer, and increasing much more gradually in size towards the adult stage. On the other hand, there are several specimens of *Bulimina elongata* var. *subulata* Cushman and Parker, which in general outline and dimensions, approach *B. aculeata*, as figured, for example, by Brady. Only the spinose characters are different, the variety *subulata* having much less clearly defined spines at the basal part. Study of a larger series of both types might very well prove them to be identical, but this has not been possible with the material at our disposition.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, near Baden. Recent, cosmopolitan.

Bulimina elongata d'Orbigny

Plate 7, figure 12

Bulimina elongata d'ORBIGNY, 1846 (not 1826), Foram. foss. Vienne, p. 187, pl. 11, figs. 19, 20; CUSHMAN and PARKER, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 49, pl. 7, figs. 1-3.

Bulimina inconstans EGGER, 1857, Neues Jahrbuch, p. 283, pl. 12, figs. 1-3, 8, 9.

Test triserial, elongate, four to five whorls to the adult specimen. Chambers distinct, inflated, gradually increasing in size as added, sutures distinct, depressed. Wall calcareous, smooth, thin, somewhat translucent, finely perforate. Aperture loopshaped, with an indistinct lip, at the base of the last-formed chamber in the apertural face.

Diameter: 0.14 to 0.38 mm; length: 0.41 to 0.76 mm.

Remarks.—In contrast to the conclusions of Cushman and Parker (1938, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 4, p. 93) I do not consider the species *Bulimina elongata* as described by d'Orbigny in 1826 and figured by Fornasini in 1901, and that described and figured by d'Orbigny in 1846 as identical. The 1826 species is extremely elongate, narrow and has a distinct tendency towards becoming uniserial in the adult stage, if somewhat irregularly so. The species in d'Orbigny's 1846 publication and topotype specimens are all close-coiled triserial throughout and are less slender. Strictly speaking, it would be justifiable to give this latter a different name, e. g. *Bulimina inconstans* Egger, according to the rules of Nomenclature. Practically, however, it would only add to the confusion of an already complicated nomenclature. It is nevertheless advisable to realize after which of the two types a determination has been made.

Bulimina elongata d'Orbignyvar. *lappa* Cushman and Parker

Plate 7, figure 14

Bulimina elongata d'Orbigny var. *lappa* CUSHMAN and PARKER, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 51, pl. 7, fig. 8.

Variety differing from the typical species in having a number of short, rounded, spinose ornamentations on the inferior part of the test, which is somewhat shorter and stouter than the type.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, and Beethovenaussicht, Vienna.

Bulimina elongata d'Orbignyvar. *subulata* Cushman and Parker

Plate 7, figures 13a, b

Bulimina elongata d'Orbigny var. *subulata* CUSHMAN and PARKER, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 51, pl. 7, figs. 6, 7.

Variety differing from the type in having well-developed spines at the base of the inferior whorls.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss; and Beethovenaussicht, Vienna.

Bulimina ovata d'Orbigny

Bulimina ovata d'ORBIGNY, 1846, Foram. foss. Vienne, p. 185, pl. 11, figs. 13, 14; CUSHMAN and PARKER, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 47, pl. 6, figs. 4, 5.

Test triserial, about 1½ to two times as long as broad, oval in outline, greatest diameter somewhat below the apertural end. Chambers relatively few,

somewhat inflated, two to three whorls to the adult specimen, the last whorl forming about one-half of the test. Sutures distinct, depressed. Wall smooth, perforate. Aperture loop-shaped, with a distinct lip.

Length: 0.40 to 0.65 mm; diameter: 0.25 to 0.36 mm.

Occurrence.—The Stephansche Ziegelei, Sooss; the Breyersche Ziegelei, Vöslau; Beethovenaussicht, Vienna; Baden.

Bulimina pupoides d'Orbigny

Bulimina pupoides d'ORBIGNY, 1846, Foram. foss. Vienne, p. 185, pl. 11, figs. 11, 12; CUSHMAN and PARKER, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 47, pl. 6, figs. 2, 3.

Test elongate, triserial, about $1\frac{1}{2}$ to two times as long as broad, very slightly flaring from the rounded initial portion. Chambers numerous, about five whorls to the adult specimen, slightly inflated. Sutures distinct, depressed. Wall smooth, perforate. Aperture loop-shaped, with a distinct lip.

Length: 0.37 to 0.82 mm; diameter: 0.20 to 0.42 mm.

Occurrence.—The Stephansche Ziegelei, Sooss, and from the Breyersche Ziegelei, Vöslau.

Bulimina pyrula d'Orbigny

Bulimina pyrula d'ORBIGNY, 1846, Foram. foss. Vienne, p. 184, pl. 11, figs. 9, 10; CUSHMAN and PARKER, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 46, pl. 6, fig. 1.

Test of medium size, about $1\frac{1}{2}$ times as long as broad, pointed at both ends. Chambers relatively few, very slightly inflated, two to three whorls to the adult specimen, the last formed whorl occupying almost the whole of the test. Sutures distinct, slightly depressed; wall smooth, distinctly perforate. Aperture loop-shaped, with a well-defined lip and tooth, at the inner margin of the last-formed chamber.

Length: 0.40 to 0.63 mm; diameter: 0.27 to 0.40 mm.

Occurrence.—The Stephansche Ziegelei, Sooss; Breyersche Ziegelei, Vöslau; Beethovenaussicht, Vienna.

Bulimina striata d'Orbigny

Bulimina striata d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 269; CUSHMAN and PARKER, 1938, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 4, p. 90, pl. 16, figs. 1-3; HOFKER, 1932, Not. Foram. des Golfes von Neapel, Pub. della St. Zool. Napoli, p. 121.

Bulimina costata d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 269; CUSHMAN and PARKER, 1938, Contr. Cushman Lab. Foram. Res., vol. 14, no. 3, p. 53, pl. 9, figs. 1, 2.

Bulimina buchiana d'ORBIGNY, 1846, Foram. foss. Vienne, p. 186, pl. 11, figs. 15-18.

Bulimina inflata SEGUENZA, 1862, Atti. Accad. Giornata Sc. Nat., ser. 2, vol. 18, p. 109, pl. 1, fig. 10; CUSHMAN, 1911, U. S. Nat. Mus. Bull. 71, pt. 2, p. 84, fig. 137; CUSHMAN, 1922, U. S. Nat. Mus. Bull. 104, pt. 3, p. 93, pl. 21, fig. 1.

Test elongate, triserial, five to six whorls to the adult specimen, about $1\frac{1}{2}$ to two times as long as broad. Chambers distinct, inflated, gradually increasing in size as added, somewhat truncate at the base. Wall calcareous, perforate, ornamented with numerous longitudinal costae, breaking off at the sutures with a downward pointing spine, except for the upper chamber of the test, which is often, although not always, smooth. Aperture comma-shaped at the inner margin of the last-formed chamber. Some specimens show an initial spine.

Length: 0.42 to 0.72 mm; diameter: 0.27 to 0.42 mm.

Remarks.—Most of the costate species have until now been considered under the name *Bulimina inflata* Seguenza, but as Cushman points out, it is quite probable that this and the other above-mentioned species are in fact identical to *Bulimina striata* d'Orbigny. They all possess the more or less truncated base of the chambers, and the abruptly ending costae. Hofker suggests that all these costate, spinose specimens are modifications of *Bulimina aculeata* d'Orbigny, which seems much less likely, inasmuch as *B. aculeata* shows no trace of costae, and moreover is not characterized by the spinose basal fringes of the chambers, as is depicted in Hofker's figures, but which indeed may be observed on some less costate specimens of *Bulimina striata*.

Our specimens are topotypes of *Bulimina buchiana* as figured by d'Orbigny in his 1846 monograph, and only show a slight difference, probably a gradation, from the other costate types figured by various authors.

Occurrence.—The Tortonian of the Stephansche Ziegelei, Sooss, near Baden. Reported from the Neogene of central European and Mediterranean regions.

Genus *Entosolenia* Ehrenberg, 1848

Entosolenia marginata (Walker and Boys)

Serpula marginata WALKER and BOYS, 1784, Test. Min., p. 2, pl. 1, fig. 7.

Lagna marginata REUSS, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 58, pl. 3, fig. 1; BRADY, 1884, Challenger Rept., vol. 9, p. 476, pl. 59, figs. 21, 22; CUSHMAN, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 37, pl. 22, figs. 1-7; CUSHMAN, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 35, pl. 6, fig. 9; CUSHMAN, 1933, U. S. Nat. Mus. Bull. 161, pt. 2, p. 17, pl. 4, figs. 9, 11, 12, 14-16, pl. 5, figs. 2, 4, 6, 8, 9.

Test single-chambered, somewhat compressed, slightly longer than broad, periphery keeled. Wall calcareous, perforate, somewhat translucent, very smooth. Aper-

ture simple, rounded, with a short neck and an internal tube.

Length: 0.27 mm; breadth: 0.24 mm; thickness: 0.24 mm.

Remarks.—As this species has a distinct internal tube, it should be placed in the genus *Entosolenia*.

Occurrence.—The Stephansche Ziegelei, Sooss, near Baden. Reported as cosmopolitan from Cretaceous to Recent.

Subfamily VIRGULININAE

Genus *Virgulina* d'Orbigny, 1826

Virgulina schreibersiana Czjzek

Virgulina schreibersiana CZJZEK, 1847, Haid. Nat. Abh., p. 147, pl. 13, figs. 18-21; REUSS, 1867, Sitz. Ber. k. Akad. Wiss. Wien, vol. 55, p. 96, pl. 4, figs. 4, 5; BRADY, 1884, Challenger Rept., vol. 9, p. 414, pl. 52, figs. 1-3; CUSHMAN, 1932, Contr. Cushman Lab. Foram. Res., vol. 8, pt. 1, p. 17, pl. 3, figs. 5a-c; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 13, pl. 2, figs. 11-20.

Test elongate, compressed, biserial, becoming somewhat irregular in the adult, three to five times longer than broad, chambers inflated, distinctly elongate. Sutures distinct, depressed. Wall calcareous, smooth, finely perforate, often with a vitreous luster.

Length: 0.40 to 0.94 mm; breadth: 0.14 to 0.24 mm; thickness: 0.10 to 0.21 mm.

Occurrence.—The Stephansche Ziegelei, Sooss, near Baden. Reported from the Upper Oligocene of Germany, Miocene of the Vienna Basin and Egypt; Pliocene of Italy and France; Recent, cosmopolitan.

Genus *Bolivina* d'Orbigny, 1839

Bolivina antiqua d'Orbigny

Bolivina antiqua D'ORBIGNY, 1846, Foram. foss. Vienne, p. 240, pl. 14, figs. 11-13; REUSS, 1857, Sitz. Ber. k. Akad. Wiss. Wien, vol. 55, p. 97; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 77, pl. 9, figs. 15, 16.

Test very elongate, three or more times longer than broad, very gradually tapering towards the initial end, strongly compressed. Periphery subacutely rounded. Chambers much broader than high, rather numerous. Sutures straight, very strongly limbate, making an angle of about 60 degrees with the horizontal. Wall thin, calcareous, translucent, distinctly perforate.

Length: 0.70 to 0.80 mm; breadth: 0.20 mm; thickness: 0.14 mm.

Remarks.—Like those figured by Cushman, our specimens have strongly limbate sutures, a feature which is not very evident in the original figures of d'Orbigny.

Occurrence.—Stephansche Ziegelei, Sooss.

Bolivina crassiseptata Marks, n. sp.

Plate 7, figures 18a, b

Test elongate, about $2\frac{1}{2}$ to three times longer than broad, almost circular in transverse section. Chambers inflated, varying from somewhat broader than high in the early portion, to higher than broad in the adult, arranged biserially. Sutures distinct, straight, making only a very small angle with the horizontal, marked by raised irregular parts of the shell, particularly in the later portion of the test. Wall calcareous, coarsely perforate, particularly at the base where it is perforate to the extent of forming a reticulate pattern. Aperture large, bolivine, at the base of the last-formed chamber.

Length: 0.20 to 0.48 mm; breadth: 0.10 to 0.17 mm; thickness: 0.10 to 0.16 mm.

Occurrence.—Holotype from the Beethovenaussicht, Vienna.

Bolivina dilatata Reuss

Bolivina dilatata REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 381, pl. 48, figs. 15a-c; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 78, pl. 9, figs. 17-20.

Test elongate, much compressed, consisting of numerous, biserially arranged chambers, about twice as long as broad. Periphery acutely rounded. Chambers about three times as broad as high; sutures distinct, somewhat limbate, very slightly if at all depressed, tending to become sigmoid, making an angle of 30 degrees with the horizontal. Wall calcareous, smooth, finely perforate. Aperture elongate oval, at the inner margin of the last-formed chamber.

Length: 0.20 to 0.42 mm; breadth: 0.10 to 0.20 mm; thickness: 0.07 mm.

Remarks.—Reuss figures a specimen with rather straight sutures, while our topotype material, and the specimens depicted by Cushman have slightly sigmoid sutures.

Occurrence.—The Beethovenaussicht, Vienna. Recorded from the Upper Oligocene of France and Italy, Miocene of Egypt, Pliocene of Italy.

Bolivina fastigia Cushman

Bolivina fastigia CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 76, pl. 9, figs. 12-14.

Test biserial, $1\frac{1}{2}$ to two times longer than broad, strongly compressed, tapering rapidly to the rounded initial end, the sides nearly parallel in the adult, periphery subacute. Chambers low, numerous; sutures distinct, limbate, peculiarly lobed, curved, making an angle of 40 to 60 degrees with the horizontal. Wall calcareous, perforate, translucent, ornamented with a longitudinal median ridge. Lower portion ornamented by indistinct roughenings. Aperture elongate, oval, at the inner side of the last-formed chamber.

Length: 0.28 to 0.35 mm; breadth: 0.15 to 0.17 mm; thickness: 0.09 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna. Recorded from the Upper Oligocene of Germany.

***Bolivina spathulata* Williamson**

Bolivina spathulata Williamson CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 162, pl. 15, figs. 20-24.

Test elongate, biserial, about two to $2\frac{1}{2}$ times as long as broad, very much compressed, periphery sharply keeled, gradually enlarging from the rounded initial end. Chambers numerous, low, regularly increasing in size as added. Sutures limbate, curved, strongly oblique, making an angle of about 45 degrees with the horizontal. Wall thin, calcareous, translucent, smooth, very finely perforate. Aperture elongate oval, at the inner margin of the last-formed chamber.

Length: 0.70 to 0.76 mm; breadth: 0.30 to 0.36 mm; thickness: 0.14 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna. Recorded from the Miocene of Egypt; recent from the British coast of the Atlantic.

***Bolivina plicatella* Cushman**

var. *mera* Cushman and Ponton

Bolivina plicatella Cushman var. *mera* Cushman and Ponton, CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 90, pl. 11, figs. 5-8.

Test small, about $1\frac{1}{2}$ times as long as broad, flaring rapidly from the base, greatest breadth at the apertural end; slightly twisted. Periphery broadly rounded. Chambers rather numerous, twelve in the adult specimen, distinct, somewhat inflated, leaving a central median groove. Sutures distinct, depressed, strongly lobulate, making an angle of about 15 degrees with the horizontal. Wall calcareous, coarsely perforate. Aperture elongate oval, at the inner margin of the last-formed chamber.

Length: 0.18 to 0.25 mm; breadth: 0.14 to 0.17 mm; thickness: 0.10 to 0.14 mm.

Occurrence.—Collected from the Tortonian marls of the Beethovenaussicht, Vienna. Originally from the Miocene of Florida.

***Bolivina trajectina* Marks, n. sp.**

Platc 7, figures 3a, b

Test small, about twice as long as broad, ovate in cross-section, periphery rounded, slightly tapering to the rounded initial end. Chambers biserially arranged, gradually increasing in size as added. Sutures indistinct, limbate, flush with the surface, making an angle of about 30 degrees with the horizontal in the early

portion and up to 45 degrees in the adult stage. Wall very smooth in the adult part of the test, the early portion with a peculiar, "moon-crater" like ornamentation. Aperture a low, arched opening at the base of the last-formed chamber.

Length: 0.28 mm; breadth: 0.14 mm; thickness: 0.10 mm.

Occurrence.—Baden, Vienna Basin, Austria.

***Bolivina viennensis* Marks, n. sp.**

Platc 7, figures 1a-2b

Test elongate, $2\frac{1}{2}$ to 3 times longer than broad, strongly compressed, regularly enlarging from the initial portion, greatest breadth somewhat below the apertural end, periphery subacute. Chambers numerous, arranged in a biserial series, about twice as broad as high, sutures distinct, strongly limbate, slightly raised above the surface of the shell, extending longitudinal lobes down the chambers, often to the extent of nearly subdividing the chambers. In the vertical median line the sutures form an irregular raised partition. Wall calcareous, roughly perforate, giving the test a peculiar "sandy" texture. Aperture terminal, elongate-oval, with raised lip.

Length: 0.52 to 0.63 mm; breadth: 0.19 to 0.23 mm; thickness: 0.10 mm.

Remarks.—The species bears a faint resemblance to *B. papulata* Cushman, but the latter lacks the extensive lobulation of the sutures and the coarse ornamentation of the wall.

Occurrence.—Collected at the Stephansche Ziegelei. Common.

Genus *Loxostomum* Ehrenberg, 1854

***Loxostomum digitale* (d'Orbigny)**

Polymorphina digitalis d'ORBIGNY, 1846, Foram. foss. Vienne, p. 235, pl. 14, figs. 1-4.

Loxostoma digitale (d'Orbigny) CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 180, pl. 21, figs. 10-12.

Test elongate, about three to four times as long as broad, compressed, periphery rounded, sides nearly parallel, tapering to the initial end, somewhat contracted toward the apertural end. Chambers distinct, much broader than high in the initial portion of the test, becoming much higher than broad in the adult; arranged biserially, tending to become somewhat uniserial in the adult. Sutures limbate, oblique in the early portion, becoming somewhat depressed and strongly curved in the adult. Wall calcareous, very distinctly perforate, often translucent, ornamented with distinct fine, numerous costae, particularly in the early portion. Aperture terminal, elliptical, with a slight lip.

Length: 0.29 to 1.10 mm; breadth: 0.10 to 0.26 mm; thickness: 0.07 to 0.19 mm.

Occurrence.—Collected from the Tortonian, Beethovenaussicht, Vienna. Common.

Genus *Bitubulogenerina* Howe, 1939

Bitubulogenerina reticulata Cushman

Plate 7, figure 17

Bitubulogenerina reticulata CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 214, pl. 24, fig. 14.

Test mostly biserial, with a very short triserial initial stage; about two to three times longer than broad, greatest breadth at the apertural end, tapering towards the initial end, periphery broadly rounded. Chambers distinct, inflated, slightly broader than high, gradually increasing in size as added. Sutures distinct, strongly depressed, oblique in the early stage, becoming horizontal in the adult. Wall calcareous, with large and tubular pores, forming a distinct reticulate pattern, and on some specimens, a horizontal ridge on the chambers. Initial chamber ornamented with a short, stout spine. Aperture large, broadly elliptical, terminal, but somewhat excentric towards the inner margin of the last-formed chamber.

Length: 0.30 to 0.45 mm; breadth: 0.14 to 0.17 mm; thickness: 0.10 to 0.14 mm.

Occurrence.—Collected from the Tortonian marls of the Beethovenaussicht, Vienna. Originally from the Miocene of the Banat region.

Subfamily REUSSELLINAE

Genus *Reussella* Galloway, 1933

Reussella pulchra Cushman

Plate 7, figure 15

Reussella pulchra CUSHMAN, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, pt. 2, p. 34, pl. 6, figs. 11, 12.

Verneuilina spinosa MACFADYEN, 1931 (non Reuss) Geol. Survey Egypt, 1930-31, p. 50, pl. 1, fig. 18.

Test triserial, only slightly longer than broad, triangular in transverse section, periphery acutely carinate, ornamented with short blunt spines. Chambers low and broad, sutures curved, slightly raised and ornamented with short spines. Wall thin, translucent, smooth, distinctly perforate. Aperture narrow, at the inner margin of the last-formed chamber, slightly curved.

Length: 0.39 mm; diameter: 0.34 mm.

Occurrence.—Collected from the Tortonian of the Stephansche Ziegelei, Sooss, the Beethovenaussicht, Vienna, and the Ziegelei Heiligenstadt. Recorded from the Vienna Basin and bordering regions; Pliocene of Italy, Miocene of Australia and Egypt. Recent from Pacific, shallow and warm water.

Reussella spinulosa (Reuss)

Verneuilina spinulosa REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 374, pl. 47, fig. 12; EGGER, 1857, Neues Jahrb., p. 292, pl. 9, fig. 17.

Reussella spinulosa (Reuss) CUSHMAN, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 33, pl. 6, figs. 8, 9.

Test triserial, somewhat elongate, about $1\frac{1}{2}$ times as long as broad, triangular in transverse section, flaring rapidly from the pointed base, greatest breadth at the apertural end. Chambers distinct, very little if any inflation, increasing very gradually in size as added, ending at the periphery in a well-developed spine. Periphery acute, somewhat carinate. Sutures distinct, somewhat limbate, flush with the surface, very slightly curved. Aperture loop-shaped, at the base of the last-formed chamber.

Length: 0.40 to 0.70 mm; width: 0.30 to 0.40 mm.

Occurrence.—Collected from the Tortonian of the Beethovenaussicht, Vienna, Stephansche Ziegelei, Sooss, and from the Ziegelei Heiligenstadt. Recorded from the Miocene of central Europe, Pliocene and Recent of the Dutch East Indies and the Pacific regions.

Reussella spinulosa (Reuss) var. *laevigata* Cushman

Reussella spinulosa (Reuss) var. *laevigata* CUSHMAN, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, pt. 2, p. 34, pl. 6, figs. 11, 12.

Variety differing from the type in lacking the spines and in having a rounded base, rather than a pointed or spinose one. The periphery is acute but not carinate.

Diameter: 0.20 mm; length: 0.33 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna, and from the Stephansche Ziegelei, Sooss, near Baden. Recorded from the Miocene of France.

Subfamily UVIGERININAE

Genus *Uvigerina* d'Orbigny, 1826

Uvigerina multicostata LeRoy

Plate 7, figure 10

Uvigerina multicostata LEROY, 1939, Nat. Tijdschr. Ned. Indie, vol. 99, afd. 6, p. 251, pl. 2, figs. 4, 5, pl. 7, figs. 3-5; 1944, Colorado Sc. of Mines Quart., vol. 39, no. 3, pt. 1, p. 31, pl. 1, figs. 49, 50.

Test elongate, about twice as long as broad, consisting of a triserial spiral, about four whorls to the adult specimen. Chambers inflated, especially those last formed, sutures distinct, strongly depressed. Wall thin, translucent, ornamented with numerous low costae, up to 15 per chamber, usually covering the whole length of the chamber, except for the last formed one, which is smooth at the upper part or completely smooth. The costae break off at the sutures with a small, but distinct, downward pointing spine.

Length: 0.31 to 0.73 mm; diameter: 0.21 to 0.38 mm.

Occurrence.—Collected from the railway cut near Vöslau, the Breyersche Ziegelei, Vöslau, and the Stephansche Ziegelei, Sooss, near Baden. Originally described by LeRoy from the Pliocene of the Dutch East Indies, it is the only species showing the typically nude last-formed chamber.

Uvigerina pygmaea d'Orbigny

Uvigerina pygmaea d'ORBIGNY, 1826 (non 1846), Ann. Sci. Nat., vol. 7, p. 269, pl. 12, figs. 8, 9; CUSHMAN, 1930, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 62, pl. 9, figs. 14-20; FRANKLIN, 1944, Jour. Paleon., vol. 18, p. 315, pl. 46, fig. 20.

Test elongate, somewhat fusiform, about twice as long as broad, consisting of a triserial series, about four whorls to the adult specimen. Chambers inflated, regularly increasing in size as added, sutures distinct, depressed. Wall finely perforate, ornamented in the lower portion of the test with numerous, well-developed costae, the last-formed chamber ornamented with numerous fine spines. Aperture terminal, with long neck and phialine lip.

Remarks.—For a detailed review of this curious species, see Cushman, 1930.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, and the Beethovenaussicht, Vienna. Rare. Recorded from the Pliocene of Italy, Recent of the Adriatic.

Uvigerina urnula d'Orbigny

Uvigerina urnula d'ORBIGNY, 1846, Foram. foss. Vienne, p. 189, pl. 11, figs. 21, 22; CUSHMAN, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, pt. 2, p. 34, pl. 8, figs. 19-25.

Test elongate, consisting of an elongate triserial spiral, tending to become irregular, four to five whorls to an adult specimen, about $2\frac{1}{2}$ times as long as broad, regularly tapering from the acute or rounded initial end. Chambers distinct, inflated, gradually increasing in size as added. Wall calcareous, thin, finely perforate, the lower part of the test ornamented with a number of very indistinct, rounded costae, covering the test to a strongly varying extent. Aperture terminal, with neck and phialine lip.

Length: 0.67 to 1.05 mm; diameter: 0.30 to 0.41 mm.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss. Recorded from the Pliocene of Italy.

Uvigerina urnula d'Orbigny var. *semiornata* (d'Orbigny)

Uvigerina semiornata d'ORBIGNY, 1846, Foram. foss. Vienne, p. 18, pl. 11, figs. 23, 24.

Uvigerina urnula d'Orbigny var. *semiornata* (d'Orbigny) CUSHMAN, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, pt. 2, p. 34, pl. 8, figs. 8-14.

Variety differing from the original in that the costae pass unbroken across the sutures, covering the entire test and not only the lower part. The name is thus paradoxical. It is also sometimes difficult to separate the variety, as all stages occur between those completely devoid of costae, through those possessing only a few costae on the lower chamber, to those with the entire test costate. It may therefore not even be justified to recognize a variety, and perhaps *Uvigerina semiornata* should be considered a synonym of *U. urnula* d'Orbigny.

Length: 0.42 mm to 1.00 mm; diameter: 0.29 to 0.42 mm.

Occurrence.—Collected at the same localities as mentioned above for *U. urnula*.

Uvigerina venusta Franzénau

Uvigerina venusta FRANZENAU, 1894, Gasick. Hrv. nar. druztva, vol. 7, pt. 6, pl. 6, figs. 60, 61; CUSHMAN, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, pt. 2, p. 38, pl. 8, figs. 15-18.

Uvigerina pygmaea d'ORBIGNY, 1846 (non 1826), Foram. foss. Vienne, p. 190, pl. 11, figs. 25, 26.

Test triserial, elongate, varying from $1\frac{1}{2}$ to 3 times longer than broad. Greatest breadth somewhat below the apertural end, pointed at the base, gradually enlarging to the rounded apertural end. Wall calcareous, ornamented with numerous distinct, longitudinal costae, breaking off at the sutures. Chambers regularly increasing in size, slightly inflated. Sutures distinct, depressed, aperture with a short stout neck and phialine lip. Lower margin of the basal coils tending to overlap the preceding coils.

Length: 0.45 to 0.90 mm; diameter: 0.30 to 0.32 mm.

Occurrence.—Collected from the Tortonian of Baden and from the Stephansche Ziegelei, Sooss.

Genus *Hopkinsina* Howe and Wallace, 1933

Hopkinsina bononiensis (Fornasini)

Plate 7, figure 8

Uvigerina bononiensis FORNASINI, 1888, Boll. Soc. Geol. Ital., vol. 7, fasc. 1, p. 48, pl. 3, figs. 12, 12a; 1898, Riv. Ital. Pal., p. 27, pl. 1, figs. 1-8 (fide CUSHMAN, 1941, p. 74); CUSHMAN, 1941, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 3, p. 74, pl. 18, fig. 1, pl. 19, figs. 14-16; COLOM, 1946, Estudios Geologicos, Num. 3, Instit. de Invest. Geol. "Lucas Mallada," p. 162, pl. 10, figs. 155, 156, 165.

Uvigerina compressa CUSHMAN, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 4, p. 10, pl. 4, figs. 2a-c.

Uvigerina szakalensis MAJZON, 1936; Magyar k. Földt. Int., Budapest, Magyarország, köt. 31, füz. 1, p. 124, pl. 5, 6.

Test free, somewhat fusiform, elongate, slightly compressed, triserial in the early portion, very rapidly becoming biserial. Chambers distinct, inflated, in the adult about as high as broad. Sutures distinct, depressed, very slightly oblique; aperture terminal, rounded, with a short, tubular neck. Wall calcareous, finely perforate, ornamented with numerous fine longitudinal striae or costae, breaking off at the sutures.

Length: 0.53 mm; breadth: 0.21 mm; thickness: 0.15 mm.

Occurrence.—Collected from the Tortonian of the Beethovenaussicht, Vienna.

Genus *Angulogerina* Cushman, 1927

Angulogerina angulosa (Williamson)

Plate 7, figure 16

Uvigerina angulosa WILLIAMSON, 1858, Recent Foram. Great Brit., p. 67, pl. 5, fig. 140; BRADY, 1884, Challenger Rept., vol. 9, p. 576, pl. 74, figs. 15, 16; CUSHMAN, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 170, pl. 41, figs. 17-20.

Angulogerina angulosa (Williamson) CUSHMAN, 1930, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 60, pl. 8, fig. 7.

Test elongate, somewhat fusiform, triangular in transverse section, triserial, tending to become somewhat uniserial towards the apertural end, tapering at both extremities, three to four whorls in the adult specimen. Chambers rapidly increasing in size as added, inflated, sutures distinct, depressed, irregularly shaped. Wall calcareous, perforate, mostly ornamented with fine, numerous costae. Aperture terminal, with neck and phialine lip.

Length: 0.23 to 0.35 mm; diameter: 0.10 to 0.16 mm.

Occurrence.—The Beethovenaussicht, Vienna, Austria.

Family ROTALIIDAE

Subfamily DISCORBINAE

Genus *Discorbis* Lamarck, 1804

Discorbis araucanus (d'Orbigny)

Discorbina araucana D'ORBIGNY, 1839, Voy. Amer. Mer., p. 44, pl. 6, figs. 16-18; BRADY, 1884, Challenger Rept., vol. 9, p. 645, pl. 86, figs. 10-11.

Discorbis auracana (d'Orbigny) CUSHMAN, 1915, U. S. Nat. Mus. Bull. 71, pt. 5, p. 15, pl. 9, fig. 3.

Test trochoid, compressed, dorsally somewhat more convex than ventrally, two to three whorls to an adult specimen, six chambers to the last whorl, periphery acutely rounded. Sutures distinct, ventrally depressed,

dorsally broadly limbate, curved, sometimes even slightly raised. Ventral umbilicus depressed, forming a star-like figure between the chambers. Wall thin, calcareous, smooth and finely perforate on the ventral side, very coarsely perforate dorsally. Aperture ventral, opening from the last-formed chamber into the umbilicus.

Diameter: 0.35 to 0.42 mm; thickness: 0.16 mm.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss and from the Beethovenaussicht, Vienna. Reported Recent from the Pacific and Atlantic Oceans.

Discorbis obtusus (d'Orbigny)

Rosalina obtusa D'ORBIGNY, 1846, Foram. foss. Vienne, p. 179, pl. 11, figs. 4-6.

Rosalina semiornata EGGER, 1857, Neues Jahrb., p. 276, pl. 8, fig. 1.

Test trochoid, much compressed, somewhat oval in outline, dorsally convex, ventrally concave, two indistinct whorls to the adult specimen, four chambers to the last whorl. Periphery subacute. Chambers rather indistinct, quickly increasing in size as added, last-formed chamber occupying almost one-half the test on the ventral side. Sutures indistinct, slightly if at all depressed, curved on the dorsal side, straight on the ventral side. Ventral umbilical area ornamented with a number of rounded plugs. Wall calcareous, coarsely perforate on the dorsal side, smooth on the ventral side except for the umbilical ornamentation.

Diameter: 0.25 to 0.51 mm; thickness: 0.11 to 0.19 mm.

Remarks.—This species shows some affinity to *Discorbis globularis* (Reuss) except for the number of chambers and the umbilical bosses. The variety *bradyi* Cushman somewhat resembles *Discorbis obtusus* in its umbilical characters.

Discorbina obtusa (d'Orbigny) of Brady (1884, Challenger Rept., vol. 9, p. 276, pl. 91, fig. 9) is not identical with the original type from Baden, but should be assigned to *Discorbis subaraucana* Cushman (Bull. 104, U. S. Nat. Museum, pt. 8, p. 32, 1931).

Occurrence.—Collected from the Beethovenaussicht, Vienna and from the Ziegelei Heiligenstadt. Miocene of southern Germany.

Discorbis pileolus (d'Orbigny)

Rosalina pileola D'ORBIGNY, 1839, Foram. Amer. Merid., p. 47, pl. 1, figs. 15-17; BRADY, 1884, Challenger Rept., vol. 9, p. 649, pl. 89, figs. 2-4.

Test trochoid, slightly compressed, circular in outline, dorsal side convex, ventral side concave. Chambers distinct, gradually increasing in size as added. Sutures distinct, somewhat limbate, strongly oblique on the dorsal side, not visible ventrally due to the radial ornamentation. Wall smooth, calcareous, perforate; on the ventral side ornamented with numerous fine radial

striae. Aperture ventral, not distinctly visible, probably opening into the deep umbilicus.

Diameter: 0.30 mm; thickness: 0.15 mm.

Occurrence.—Only one specimen has been obtained, from the Breyersche Ziegelei, Vöslau. Recorded from the Eocene of France, Miocene of the Mediterranean region, Recent of the Atlantic and Pacific oceans, shallow water.

Genus *Valvulineria* Cushman, 1926

Valvulineria complanata (d'Orbigny)

Plate 6, figures 13a-c

Rosalina complanata d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 175, pl. 10, figs. 13-15; REUSS, 1850, *Denkschr. k. Akad. Wiss. Wien*, vol. 1, p. 373, pl. 47, fig. 5. *Valvulineria complanata* (d'Orbigny) CUSHMAN, 1926, *Contr. Cushman Lab. Foram. Research*, vol. 12, pt. 3, p. 59.

Test trochoid, close-coiled, compressed, two whorls to the adult specimen, the seven to nine chambers of the last whorl visible ventrally. Periphery somewhat acutely rounded, lobulate. Ventral side strongly umbilicate, chambers increasing rather rapidly in size as added, somewhat inflated, especially the last-formed one. Sutures oblique, curved, slightly depressed, somewhat more so on the ventral side. Wall thin, smooth, distinctly perforate. Aperture large, extending from the umbilical area almost to the periphery on the ventral side of the test. In well-preserved specimens a thin plate extends from the apertural face over the aperture, partly covering the umbilical region.

Diameter: 0.28 to 0.45 mm.

Remarks.—The specimen figured by Reuss, as *Rosalina complanata* d'Orbigny var., is actually closer to our material than those figured originally by d'Orbigny, the former having a larger number of chambers than the latter.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss; Beethovenaussicht, Vienna, and from several localities near Baden.

Genus *Gyroidina* d'Orbigny, 1826

Gyroidina soldanii d'Orbigny

Gyroidina soldanii d'ORBIGNY, 1826, *Ann. Sci. Nat.*, vol. 7, p. 278; PARKER, JONES and BRADY, 1865, *Ann. Mag. Nat. Hist.*, vol. 16, p. 25, mod. 36, pl. 3, fig. 86; CUSHMAN, 1915, *U. S. Nat. Mus. Bull.* 71, pt. 5, p. 71, pl. 20, fig. 1; CUSHMAN, 1931, *U. S. Nat. Mus. Bull.* 104, pt. 8, p. 38, pl. 8, figs. 3-8; R. E. and K. C. STEWART, 1930, *Jour. Paleon.*, vol. 4, no. 1, pl. 8, figs. 9a-c, pl. 9, figs. 1a-c.

Rosalina soldanii d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 155, pl. 8, figs. 10-12; BRADY, 1884, *Challenger Rept.*, vol. 9, p. 706, pl. 107, figs. 6, 7.

Rotalina girardana REUSS, 1851, *Zeitschr. deutsche geol. Gesell.*, vol. 3, p. 73, pl. 5, fig. 34.

Rotalina nitidula SCHWAGER, 1866, *Novara Exped.*, p. 263, pl. 7, fig. 110.

Test trochoid, somewhat compressed, evolute, periphery acutely rounded, dorsal side almost flat, with a definite channel between the whorls, ventral side strongly convex, with a prominent central umbo. Chambers distinct, numerous, seven to eight in the last whorl, increasing very gradually in size as added. Sutures straight, limbate, slightly depressed. Wall calcareous, smooth, finely perforate. Aperture an elongate slit in the apertural face, which is ventral, large, and at right angles to the periphery.

Diameter: 0.28 to 0.52 mm; thickness: 0.17 to 0.28 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna; Breyersche Ziegelei, Vöslau, Roth-Neusiedl, and from Baden. Reported from the Oligocene of Germany, Miocene of central Europe and Mediterranean regions, Recent cosmopolitan.

Subfamily ROTALIINAE

Genus *Eponides* Montfort, 1808

Eponides haidingeri (d'Orbigny)

Plate 8, figures 10a-c

Rotalina haidingeri d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 154, pl. 8, figs. 7-9. All other references are doubtfully synonymous.

Rotalia bruckneri REUSS, 1855, *Zeitschr. deutsche geol. Gesell.*, vol. 7, p. 273, pl. 9, fig. 7.

Rotalia propinqua REUSS, 1855, *Sitz. Ber. k. Akad. Wiss. Wien*, vol. 18, p. 241, pl. 4, fig. 53.

Rotalina propinqua (Reuss) EGGER, 1857, *Neues Jahrb.*, p. 275, pl. 7, figs. 14-17.

Rotalina badensis CZJZEK, 1848, *Haidingers Nat. Abh.*, vol. 2, p. 145, pl. 12, figs. 1-3.

Not: *Truncatulina haidingeri* BRADY, 1884, *Challenger Rept.*, vol. 9, p. 663, pl. 95, figs. 7a-c.

Rotalina haidingeri EGGER, 1857, *Neues Jahrb.*, p. 275, pl. 7, figs. 11-13.

Test trochoid, not much compressed, more convex dorsally than on the ventral side, consisting of about four whorls in the adult, six chambers visible in the last whorl. Chambers distinct, numerous, very gradually increasing in size as added, somewhat inflated ventrally. Sutures distinct dorsally, strongly oblique, limbate, very slightly if at all depressed; on the ventral side distinctly depressed, straight, radiate. Ventral umbilicus depressed; periphery subacute to angular. Wall calcareous, smooth, distinctly perforate, especially on the ventral side. Aperture ventral, a low, arched opening at the base of the last-formed chamber.

Diameter: 0.77 mm; thickness: 0.49 mm.

Remarks.—*Eponides haidingeri*, as figured by Brady,

bears a superficial resemblance to the original type of d'Orbigny, but differs from it in the main characteristics, having no less than nine chambers in the last whorl, and lacking the wide and deep umbilical depression.

Occurrence.—Collected from the Beethovenaussicht, Vienna. Very rare.

Eponides nanus (Reuss)

Rotalina nana REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 371, pl. 46, fig. 23.

Eponides nanus (Reuss) CUSHMAN and LAI-MING, 1931, Jour. Paleon., vol. 5, no. 2, p. 115, pl. 13, figs. 3, 4.

Test trochoid, much compressed, about three whorls to an adult specimen, five to six chambers to the last whorl, periphery acute, narrowly keeled, somewhat lobulate, ventral umbilicus filled with clear shell material. Chambers distinct, rather uniform in shape, very gradually increasing in size as added, slightly inflated on the ventral side. Sutures distinct, strongly oblique on both sides, slightly depressed only on the ventral side. Wall calcareous, thin, finely perforate.

Diameter: 0.35 to 0.40 mm; thickness: 0.17 to 0.23 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna, and from the Stephansche Ziegelei, Sooss.

Genus *Rotalia* Lamarck, 1804

Rotalia viennensis (d'Orbigny)

Plate 8, figures 7a-c

Rotalina viennensis D'ORBIGNY, 1846, Foram. foss. Vi-
enne, p. 177, pl. 10, figs. 22-24; EGGER, 1857, Neues
Jahrb., p. 277, pl. 8, fig. 11.

Test trochoid, much compressed, consisting of three whorls in the adult, seven to eight chambers in the last whorl. Chambers distinct, numerous, gradually increasing in size as added, not quite touching ventrally and with the umbo forming a stellate opening. Sutures distinct, depressed, and slightly curved on the ventral side; oblique, curved and limbate dorsally. Aperture large, ventral, at the base of the last-formed chamber, opening into the umbilicus. Wall calcareous, thin, smooth, finely perforate, somewhat translucent.

Diameter: 0.56 mm; thickness: 0.28 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna.

Subfamily SIPHONININAE

Genus *Epistomina* Terquem, 1883

Epistomina elegans (d'Orbigny)

Turbinulina elegans D'ORBIGNY, 1826, Ann. Sci. Nat.,
vol. 7, p. 276, no. 54.

Rotalina parischiana D'ORBIGNY, 1846, Foram. foss. Vi-
enne, p. 153, pl. 7, figs. 28-30, pl. 8, figs. 1-3; BRADY,

1884, Challenger Rept., vol. 9, p. 699, pl. 105, figs.
3-6.

Epistomina elegans (d'Orbigny) CUSHMAN, 1927, Contr.
Cushman Lab. Foram. Res., vol. 3, pt. 4, p. 182, pl.
31, figs. 1-6, pl. 32, figs. 1-8.

Test trochoid, compressed, both sides equally convex, consisting of two to three whorls in the adult, seven chambers in the last whorl, periphery acute. Chambers distinct, not inflated, gradually increasing in size as added. Sutures very distinct, thick, strongly limbate, very oblique and curved on the dorsal side, oblique and straight on the ventral side, which has a distinct umbonate disk. Wall calcareous, finely perforate, thick, smooth, often with peculiar figures, sometimes translucent. Aperture a narrow slit at the ventral margin of the chamber. Secondary apertures on the ventral side of the chambers, consisting of elongate slits, nearly peripheral in the axis of coiling.

Diameter: 0.45 mm; thickness: 0.24 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna, Zeigelei Heiligenstadt, and from Roth-Neusiedl. Recorded from the Miocene of Europe, Australia, Pliocene of California; Recent, very cosmopolitan.

Genus *Siphonina* Reuss, 1850

Siphonina reticulata (Czjzek)

Plate 8, figures 8a-c

Rotalina reticulata CZJZEK, 1848, Haid. Nat. Abh., vol.
2, p. 145, pl. 13, figs. 7, 8.

Siphonina fimbriata REUSS, 1850, Denkschr. k. Akad.
Wiss. Wien, vol. 1, p. 372, pl. 47, fig. 6.

Siphonina reticulata (Czjzek) CUSHMAN, 1931, U. S.
Nat. Mus. Bull. 104, pt. 8, p. 68, pl. 14, figs. 1a-c.

Test trochoid, compressed, about equally bi-convex, periphery acutely keeled, fimbriate; test consisting of about three whorls, marked by the fimbriate margin, four chambers to the last whorl, slightly inflated, regularly increasing in size. Sutures distinct, depressed, radiate ventrally, curved dorsally, well marked by the fimbriation on the periphery of the chambers. Aperture ventral, with a short elliptical neck and phialine lip. Wall calcareous, finely perforate, smooth, somewhat translucent.

Diameter: 0.35 to 0.50 mm; thickness: 0.24 to 0.30 mm.

Remarks.—*Truncatulina reticulata* Brady (non Czjzek), 1884, (Challenger Rept., vol. 9, p. 699, pl. 96, fig. 8) should be classed as *Siphonina bradyana* Cushman (1931, U. S. Nat. Mus. Bull. 104, pt. 8, p. 70, pl. 14, fig. 4).

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, near Baden, and from a locality near Baden. Recorded from the Recent, Atlantic Ocean.

Subfamily BAGGININAE

Genus *Cancris* Montfort, 1808*Cancris auriculus* (Fichtel and Moll)

Nautilus auricula FICHTEL and MOLL, 1803, Test Micr., p. 108, pl. 20, figs. a-c (var. a), p. 110, pl. 20, figs. d-f (var. b).

Rotalia brogniartii d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 273; d'ORBIGNY, 1846, Foram. foss. Vienne, p. 158, pl. 8, figs. 22-24.

Rotalia elliptica d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 273.

Rotalia scaphoidea REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 372, pl. 47, fig. 3.

Pulvinulina auricula (Fichtel and Moll) BRADY, 1884, Challenger Rept., vol. 9, p. 688, pl. 106, fig. 5; CUSHMAN, 1921, U. S. Nat. Mus. Bull. 100, pt. 4, p. 329, pl. 69, fig. 3.

Pulvinulina oblonga Williamson, BRADY, 1884, Challenger Rept., vol. 9, p. 688, pl. 106, fig. 4.

Cancris auriculus (Fichtel and Moll) LeROY, 1931, Colo. School of Mines Quart., vol. 36, no. 1, pt. 3, p. 117, pl. 3, figs. 7-9, 16-18; CUSHMAN, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, pt. 4, p. 74, pl. 18, figs. 1-11, pl. 23, fig. 6.

Test trochoid, compressed, oval in outline; periphery acute, with a narrow keel. Chambers distinct, increas-

ing very rapidly in size as added, of rather uniform shape, somewhat inflated ventrally. Sutures distinct, slightly curved, depressed on the ventral side, somewhat limbate dorsally. Ventral umbo depressed, covered by a thin plate, extending from the last-formed chamber. Aperture ventral, a narrow slit at the base of the last-formed chamber, in well-preserved specimens covered by the umbilical plate. Wall thin, calcareous, perforate, somewhat translucent.

Length: 0.22 to 0.52 mm; breadth: 0.16 to 0.48 mm; thickness: 0.14 to 0.27 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna, and from the Breyersche Ziegelei, Vöslau. Recorded from the Neogene of central and southern Europe, America and the East Indian Archipelago. Recent, cosmopolitan.

Family AMPHISTEGINIDAE

Genus *Asterigerina* d'Orbigny, 1839*Asterigerina planorbis* d'Orbigny

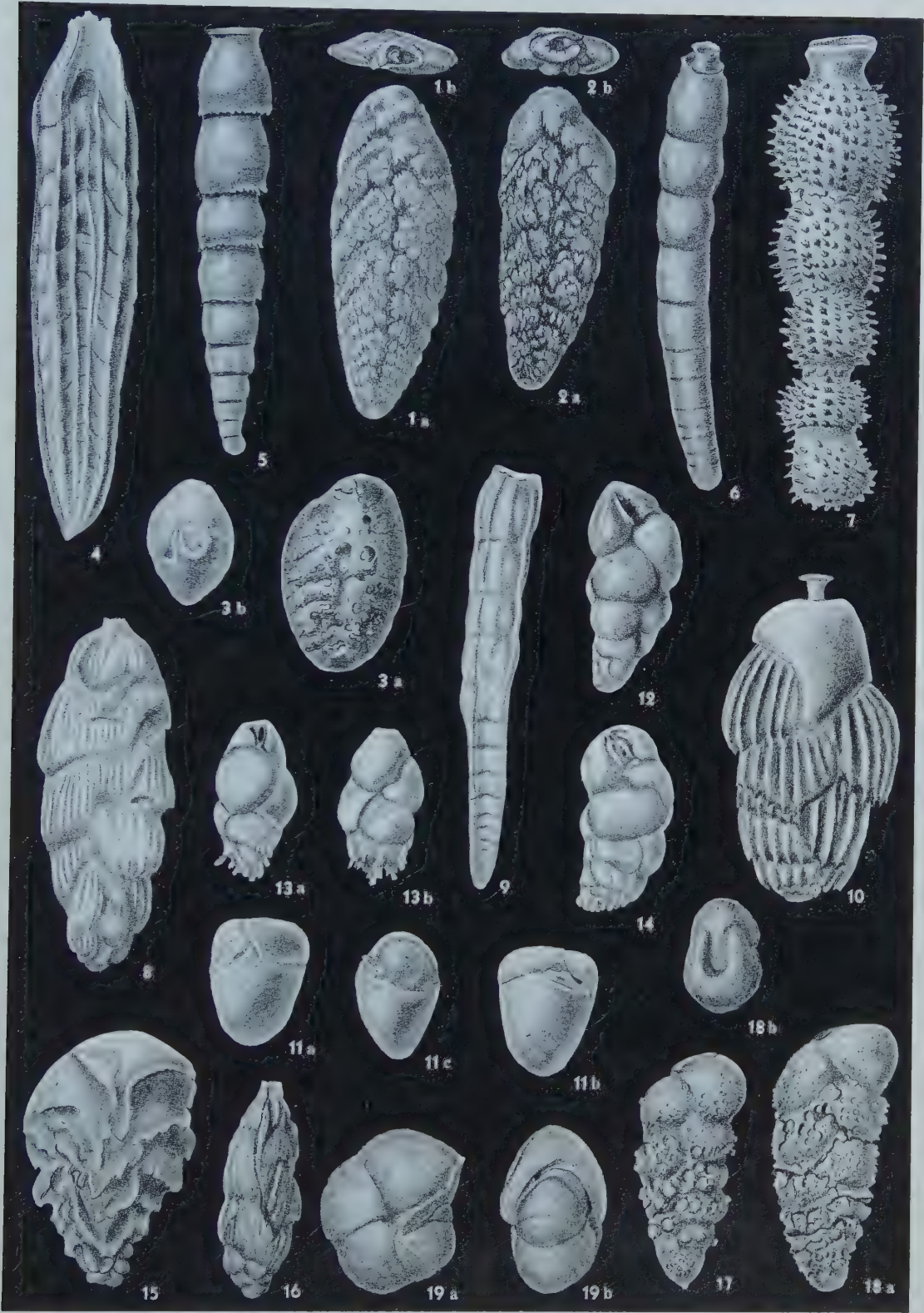
Plate 8, figures 1a-c

Asterigerina planorbis d'ORBIGNY, 1846, Foram. foss. Vienne, p. 205, pl. 11, figs. 1-3.

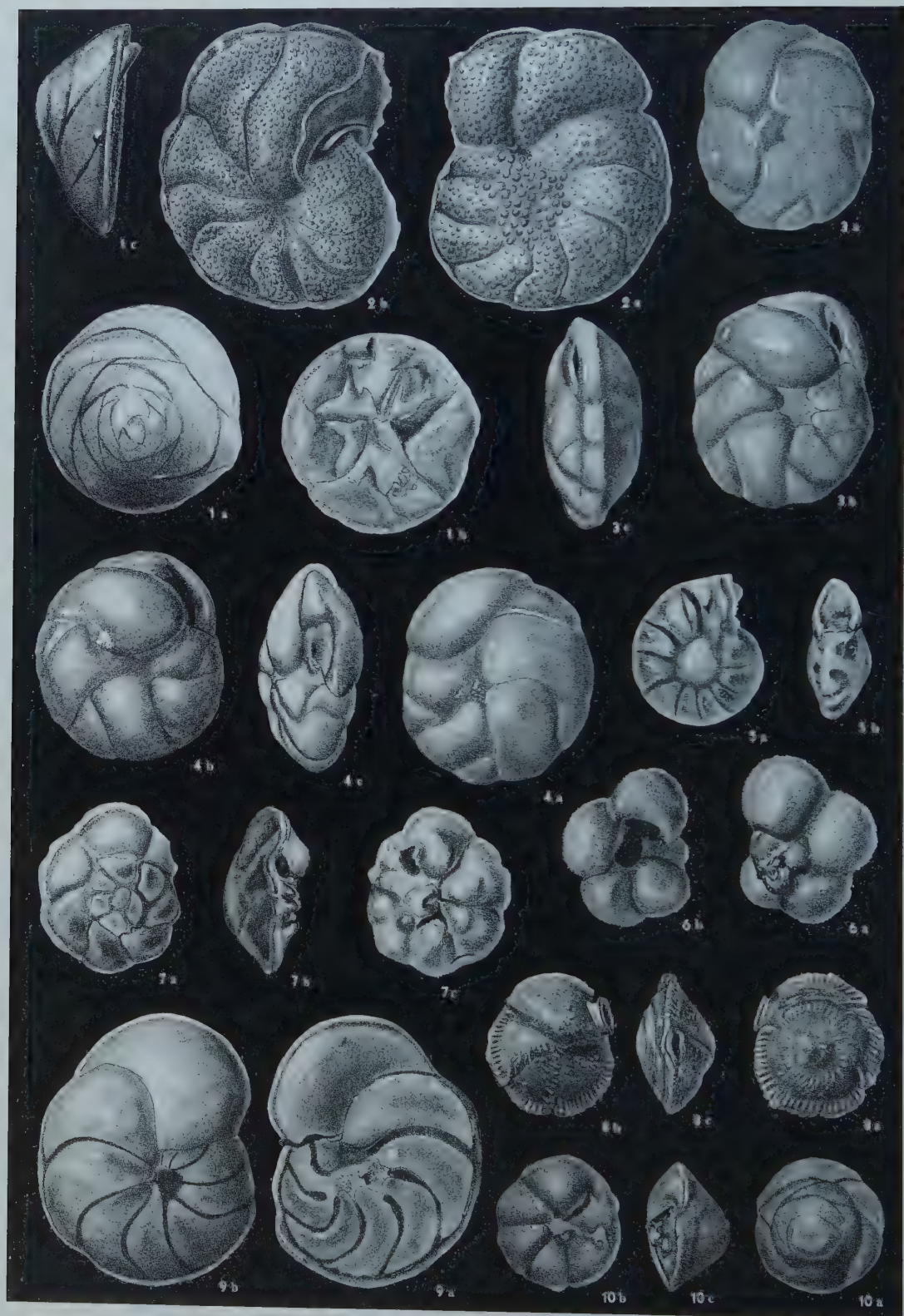
Test trochoid, strongly plano-convex, much depressed, circular in outline, two to three whorls to the adult specimen, periphery acute. Four to six chambers visible

EXPLANATION OF PLATE 7

| FIGS. | | PAGE |
|---------|--|------|
| 1a-2b. | <i>Bolivina viennensis</i> Marks, n. sp. Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. 1a, side view of holotype, 1b, apertural view; 2a, side view of paratype, 2b, apertural view, all $\times 55$. | 60 |
| 3a, b. | <i>Bolivina trajectina</i> Marks, n. sp. Miocene, Sooss, Vienna Basin. 3a, side view of holotype, 3b, apertural view, $\times 55$. | 60 |
| 4. | <i>Plectofrondicularia digitalis</i> (Neugeboren). Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. $\times 40$. | 54 |
| 5. | <i>Nodogenerina bradyi</i> Cushman. Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. Lateral view, $\times 40$. | 55 |
| 6. | <i>Nodogenerina pauperata</i> (d'Orbigny). Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. Lateral view, $\times 55$. | 56 |
| 7. | <i>Nodogenerina hirsuta</i> (Soldani). Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. Lateral view, $\times 55$. | 56 |
| 8. | <i>Hopkinsina bononiensis</i> (Fornasini). Miocene, Beethovenaussicht, Vienna. Lateral view of hypotype, $\times 55$. | 62 |
| 9. | <i>Amphimorphina haueriana</i> Neugeboren. Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. Lateral view, $\times 55$. | 54 |
| 10. | <i>Urigerina multicostata</i> LeRoy. Miocene, Breyersche Ziegelei, Vöslau, Vienna Basin. Lateral view, $\times 50$. | 61 |
| 11a-c. | <i>Allomorphina trigona</i> Reuss. Miocene, Baden, Vienna Basin. 11a, Dorsal view, 11b, ventral view, 11c, peripheral view, $\times 40$. | 69 |
| 12. | <i>Bulimina elongata</i> d'Orbigny. Miocene, Baden, Vienna Basin. Lateral view, $\times 40$. | 57 |
| 13a, b. | <i>Bulimina elongata</i> d'Orbigny, var. <i>subulata</i> Cushman and Parker. Miocene, Stephansche Ziegelei, Sooss near Baden, Vienna Basin. 13a, front view, 13b, back view, $\times 40$. | 57 |
| 14. | <i>Bulimina elongata</i> d'Orbigny var. <i>lappa</i> Cushman and Parker. Miocene, Beethovenaussicht, Vienna. Lateral view, $\times 40$. | 57 |
| 15. | <i>Reussella pulchra</i> Cushman. Miocene, Beethovenaussicht, Vienna. Lateral view, $\times 55$. | 61 |
| 16. | <i>Angulogerina angulosa</i> (Williamson). Miocene, Beethovenaussicht, Vienna, Vienna Basin. Lateral view, $\times 40$. | 63 |
| 17. | <i>Bitubulogenerina reticulata</i> Cushman. Miocene, Beethovenaussicht, Vienna. Lateral view, $\times 55$. | 61 |
| 18a, b. | <i>Bolivina crassiseptata</i> Marks, n. sp. Miocene, Beethovenaussicht, Vienna Basin. 18a, Lateral view of holotype, 18b, apertural view, $\times 55$. | 59 |
| 19a, b. | <i>Pullenia quinqueloba</i> (Reuss). Miocene, Baden, Vienna Basin. 19a, Side view, 19b, peripheral view, $\times 55$. | 69 |



Marks, Vienna Basin Miocene Foraminifera



Marks, Vienna Basin Miocene Foraminifera

ventrally, not including the secondary chambers which form a stellate arrangement. Sutures distinct, limbate dorsally, very oblique; radiate ventrally, slightly sigmoid, somewhat lobulate between the secondary chambers, slightly depressed. Wall thin, smooth, very finely perforate, somewhat translucent.

Diameter: 0.36 to 0.54 mm; thickness: 0.18 to 0.22 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna and from the Stephansche Ziegelei, Sooss, near Baden. Common.

Genus *Amphistegina* d'Orbigny, 1826

Amphistegina lessonii d'Orbigny

Amphistegina lessonii d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 304, no. 3, pl. 17, figs. 1-4; PARKER, JONES and BRADY, 1857, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 34, pl. 3, fig. 92; BRADY, 1884, Challenger Rept., vol. 9, p. 740, pl. 111, figs. 1-7; CUSHMAN, 1914, U. S. Nat. Mus. Bull. 71, pt. 4, p. 35, pl. 19, fig. 2; CUSHMAN, 1931, U. S. Nat. Mus. Bull. 104, pt. 8, p. 79, pl. 16, figs. 1-3.

Amphistegina vulgaris d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 304, no. 4; PARKER, JONES and BRADY, 1857, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 25, pl. 3, fig. 91.

Amphistegina hauerina d'ORBIGNY, 1846, Foram. foss. Vienne, p. 107, pl. 12, figs. 3-5.

Amphistegina mammillata d'ORBIGNY, 1846, Ibid., p. 208, pl. 12, figs. 6-8.

As this species is very widely known, it is unnecessary to give another detailed description.

Thalmann (1932, *Ecolae Helvet.*, p. 311) in his *nomena mutata* on Brady's Challenger report, changed the name of this species to *Amphistegina radiata* (Fichtel and Moll), which seems very probable, except for the

inaccessability of Fichtel and Moll's original work. Cushman (1946) in discussing the species described by Fichtel and Moll (Cushman Lab. Foram. Res., Spec. Publ. 17) did not offer either a description or figure of the type of *Nautilus radiatus* Fichtel and Moll (Test. Micr., 1798, p. 58, pl. 8, figs. a-d). Therefore, as the name *Amphistegina lessonii* is so commonly in use, it seems unnecessary to insist upon the prevalence of a name based on such primitive figures and descriptions as were furnished by the early 19th century authors, Fichtel and Moll.

Occurrence.—Found in all Tortonian localities. Recent Alps; Miocene of central and Mediterranean Europe; Recent, in warm, shallow parts of the Atlantic and Pacific Oceans.

Family CASSIDULINIDAE

Subfamily CERATOBULIMININAE

Genus *Ceratobulimina* Toulou, 1915

Ceratobulimina haueri (d'Orbigny)

Recorded from the Eocene of the Paris Basin, southwest-
Rotalina haueri d'ORBIGNY, 1846, Foram. foss. Vienne, p. 152, pl. 7, figs. 22-24.

Ataxophragmium simile KARRER, 1868, Sitz. Ber. k. Akad. Wiss. Wien, vol. 58, p. 126, pl. 1, fig. 1.

?*Rotalina contraria* REUSS, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 76, pl. 5, fig. 37; BRADY, 1884, Challenger Rept., vol. 9, p. 409, pl. 54, fig. 18.

Ceratobulimina haueri (d'Orbigny) CUSHMAN, 1927, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 2, p. 175, pl. 29, figs. 6-10.

Test trochoid, slightly compressed, consisting of about 1½ volutions, periphery broadly rounded. Chambers distinct, slightly inflated, very quickly increasing in size as added, eight visible in the last whorl. Sutures distinct, somewhat depressed, becoming more so to-

EXPLANATION OF PLATE 8

| FIGS. | | PAGE |
|--------|--|------|
| 1a-c. | <i>Asterigerina planorbis</i> d'Orbigny. Miocene, Beethovenaussicht, Vienna, Vienna Basin. 1a, dorsal view, 1b, ventral view, 1c, peripheral view, × 44. | 66 |
| 2a, b. | <i>Cibicides ungerianus</i> (d'Orbigny). Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. 2a, dorsal view, 2b, ventral view, × 44. | 73 |
| 3a-4c. | <i>Cassidulina cruyi</i> Marks, n. sp. Miocene, Beethovenaussicht, Vienna, Vienna Basin. 3a, Dorsal view of paratype, 3b, ventral view, 3c, apertural view; 4a, dorsal view of holotype, 4b, ventral view, 4c, peripheral view, all × 44. | 68 |
| 5a, b. | <i>Anomalina</i> sp. Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. 5a, dorsal view, 5b, peripheral view, × 44. | 71 |
| 6a, b. | <i>Globigerina concinna</i> Reuss. Miocene, Stephansche Ziegelei, Sooss, Vienna Basin. 6a, dorsal view, 6b, ventral view, × 32. | 70 |
| 7a-c. | <i>Rotalia viennensis</i> (d'Orbigny). Miocene, Beethovenaussicht, Vienna, Vienna Basin. 7a, dorsal view, 7b, ventral view, 7c, peripheral view, × 44. | 65 |
| 8a-c. | <i>Siphonina reticulata</i> (Czjzek). Miocene, Baden, Vienna Basin. 8a, dorsal view, 8b, ventral view, 8c, peripheral view, × 44. | 65 |
| 9a, b. | <i>Cibicides boueanus</i> (d'Orbigny). Miocene, Baden, Vienna Basin. 9a, ventral view, 9b, dorsal view, × 44. | 72 |
| 10a-c. | <i>Eponides haidingeri</i> (d'Orbigny). Miocene, Beethovenaussicht, Vienna Basin. 10a, Dorsal view, 10b, ventral view, 10c, peripheral view, × 28. | 64 |

wards the center of the test, which has a distinctly depressed umbilicus. Wall smooth, finely perforate, often with a glassy lustre. Aperture ventral, in the apertural face, consisting of an elongate slit in the axis of coiling, and a rounded slit pointing toward the periphery. In well preserved specimens the aperture and the apertural face are covered by a thin plate, with a slightly up-turned border covering the umbilical region.

Length: 0.49 to 0.64 mm; breadth: 0.30 to 0.48 mm; thickness: 0.22 to 0.36 mm.

Occurrence.—Collected from the Breyersche Ziegelei, Vöslau.

Subfamily CASSIDULININAE

Genus *Cassidulina* d'Orbigny, 1826

Cassidulina crassa d'Orbigny

Cassidulina crassa d'ORBIGNY, 1839, *Foram. Amer. Merid.*, p. 56, pl. 7, figs. 18-20; d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 213, pl. 21, figs. 42, 43; BRADY, 1884, *Challenger Rept.*, vol. 9, p. 429, pl. 54, figs. 4, 5; CUSHMAN, 1911, *U. S. Nat. Mus. Bull.* 71, pt. 2, p. 96, fig. 151; CUSHMAN, 1922, *U. S. Nat. Mus. Bull.* 104, pt. 3, p. 124, pl. 26, fig. 7; CUSHMAN, 1924, *Contr. Cushman Lab. Foram. Res.*, vol. 1, pt. 1, p. 54, pl. 8, figs. 37-39.

Cassidulina oblonga REUSS, 1850, *Denkschr. k. Akad. Wiss. Wien*, vol. 1, p. 376, pl. 18, figs. 5-6.

Test circular in outline, involute, occasionally elongate to oval, compressed, periphery broadly rounded. Chambers biserially arranged, in a planispiral coil, inflated, very gradually increasing in size as added. Sutures depressed, distinct. Wall thin, calcareous, smooth, finely perforate. Aperture an elongate, narrow slit, nearly parallel to the periphery, often with a distinct tooth.

Length: 0.18 to 0.35 mm; breadth: 0.14 to 0.29 mm; thickness: 0.14 to 0.22 mm.

Remarks.—There seems to be no important difference between *Cassidulina crassa* and *Cassidulina oblonga*, the only distinction being the somewhat greater relative length of *Cassidulina oblonga*, resulting in a slightly oval rather than circular outline. Both Brady and Cushman (1924, *Contr. Cushman Lab. Foram. Res.*, vol. 1, pt. 1, p. 56, pl. 9, figs. 19-22) affirm the probable synonymy of the two species, although in his 1925 Contributions Cushman again considered them as separate species.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss. Middle Tertiary of central Europe, Miocene of the Vienna Basin, Pliocene of Italy, Recent, widespread in both the Atlantic and Pacific Oceans.

Cassidulina cruysi Marks, n. sp.

Plate 5, figures 3a-4c

Test of moderate size, circular in outline, somewhat compressed, lenticular in shape; periphery somewhat subacutely rounded; completely involute. Chambers distinct, arranged in a planispirally coiled, biserial series, four to five pair visible in the adult specimen. Sutures distinct, curved, slightly depressed, somewhat limbate on the dorsal side. Umbilical area filled or covered with clear shell material. Aperture small, elongate in the axis of coiling, in the elongate apertural face at the base of the last-formed chamber. Wall finely and densely perforate, smooth, color yellowish-brown.

Diameter: 0.24 to 0.43 mm; thickness: 0.17 to 0.22 mm.

Remarks.—The species is named for Mr. H. Cruys, micropaleontologist at the State University of Utrecht.

Occurrence.—Collected from the Beethovenaussicht, Vienna.

Cassidulina laevigata d'Orbigny

Cassidulina laevigata d'ORBIGNY, 1826, *Ann. Sci. Nat.*, vol. 7, p. 282, pl. 15, figs. 4-5; PARKER, JONES and BRADY, 1863, *Ann. Mag. Nat. Hist.*, ser. 3, vol. 16, p. 25, pl. 2, fig. 67; BRADY, 1884, *Challenger Rept.*, vol. 9, p. 428, pl. 54, figs. 1-3; CUSHMAN, 1911, *U. S. Nat. Mus. Bull.* 71, pt. 2, p. 96, fig. 150; CUSHMAN, 1922, *U. S. Nat. Mus. Bull.* 104, pt. 3, p. 122, pl. 24, fig. 4; CUSHMAN, 1924, *Contr. Cushman Lab. Foram. Res.*, vol. 1, pt. 1, p. 52, pl. 15, figs. 4-5.

Cassidulina punctata REUSS, 1850, *Denkschr. k. Akad. Wiss. Wien*, vol. 1, p. 367, pl. 58, fig. 4.

Test nearly circular in outline, much compressed, periphery acute. Chambers narrow, biserially arranged in a planispiral coil, involute, five chambers visible on either side. Sutures distinct, slightly depressed. Wall thin, smooth, distinctly perforate, often translucent. Aperture a narrow slit in the apertural face, parallel to the periphery.

Diameter: 0.17 to 0.32 mm; thickness: 0.09 to 0.20 mm.

Remarks.—The original figures by d'Orbigny distinctly indicate a specimen with only five chambers visible on either side. Brady figures a specimen with six chambers, and Cushman in his *Bulletins* shows a type with not less than nine very narrow chambers. It seems rather doubtful that these last-mentioned specimens actually belong to the original type, as is certainly the case with the Vienna Basin specimens.

Occurrence.—Collected from the Beethovenaussicht, Vienna, and from the Stephansche Ziegelei, Sooss. Originally from ballast sand of unknown origin. Recorded from the Tertiary of central Europe, the Mediterranean and Atlantic European regions. Doubtfully Recent from the Atlantic, Pacific, and Mediterranean in cool water.

Family CHILOSTOMELLIDAE
Subfamily ALLOMORPHININAE
Genus *Allomorphina* Reuss, 1850

Allomorphina trigona Reuss

Plate 7, figures 11a-c

Allomorphina trigona REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 380, pl. 48, figs. 14; BRADY, 1884, Challenger Rept., vol. 9, p. 438, pl. 55, figs. 24-26; CUSHMAN, 1914, U. S. Nat. Mus. Bull. 71, pt. 4, p. 3, pl. 1, figs. 6-8; CUSHMAN, 1924, U. S. Nat. Mus. Bull. 104, pt. 5, p. 4, pl. 1, figs. 11-13.

Test trochoid, three chambers to an adult whorl, somewhat triangular in outline; chambers inflated, increasing very rapidly in size as added, strongly involute, last chamber occupying nearly the whole of the test, earlier whorls indistinctly visible on the dorsal side. Sutures distinct, very slightly depressed; wall finely perforate, thin, somewhat translucent. Aperture ventral, a low arched slit at the inner margin of the last-formed chamber, with a narrow but distinct lip.

Length: 0.32 to 0.45 mm; breadth: 0.27 to 0.37 mm.

Occurrence.—Collected from the Tortonian of Baden.

Subfamily CHILOSTOMELLINAE

Genus *Chilostomella* Reuss, 1850

Chilostomella ovoidea Reuss

Chilostomella ovoidea REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 380, pl. 48, fig. 12; BRADY, 1884, Challenger Rept., vol. 9, p. 436, pl. 55, figs. 12, 13, 15, 16, 19-23.

Test composed of several chambers, each chamber 180 degrees from the preceding, all visible from the dorsal side, the two last-formed ones making up nearly the whole of the test. Chambers increasing very rapidly in size as added; the last-formed chamber covering most of the preceding ones; sutures not depressed, rather indistinct, wall smooth, thin, translucent, usually conspicuously punctate; aperture a curved, somewhat arched opening between the base of the chamber and the preceding one, often with a thickened, somewhat flaring lip.

Length: up to 1.0 mm; diameter: up to 0.40 mm.

Occurrence.—Collected from the Tortonian of Baden. Recent, widespread.

Subfamily ALLOMORPHINELLINAE

Genus *Pullenia* Parker and Jones, 1862

Pullenia bulloides (d'Orbigny)

Nonionina bulloides D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 293; D'ORBIGNY, 1846, Foram. foss. Vienn., p. 107, pl. 5, figs. 9, 10.

Pullenia bulloides (d'Orbigny) KLEINPELL, 1938, Miocene Stratig. of Calif., p. 338, pl. 5, figs. 10, 13; CUSHMAN, 1943, Contr. Cushman Lab. Foram. Res., vol. 19, pt. 1, p. 13, pl. 2, figs. 15-18.

Pullenia sphaeroides (d'Orbigny) BRADY, 1884, Challenger Rept., vol. 9, p. 615, pl. 84, figs. 12, 13.

Test planispiral, involute, subglobular, four to five chambers visible in the last whorl, very slightly compressed. Chambers uniform in shape, very gradually increasing in size as added. Wall calcareous, smooth, finely perforate. Aperture very low, extending to the umbilicus on either side. Sutures distinct, straight, radial, faintly limbate, slightly if at all depressed.

Diameter: 0.27 to 0.40 mm; thickness: 0.27 to 0.44 mm.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, the Beethovenaussicht, Vienna, Baden, and from Roth-Neusiedl. Recorded from the Miocene of central Europe, Egypt, Australia, California; Pliocene of Italy, France, Spain, California, Dutch East Indies; Recent from the Atlantic and Pacific Oceans.

Pullenia miocenica Kleinpell

Pullenia miocenica KLEINPELL, 1938, Miocene Stratig. of Calif., p. 338, pl. 14, fig. 6; CUSHMAN, 1943, Contr. Cushman Lab. Foram. Res., vol. 19, pt. 1, p. 17, pl. 3, figs. 3, 4.

Test planispiral, completely involute, subglobular, slightly compressed laterally; chambers slightly inflated, regularly increasing in size as added, six to seven in the last whorl. Sutures distinct, depressed, straight, radiate. Wall calcareous, very smooth, finely perforate. Aperture low, extending to the umbilicus on either side, at the base of the apertural face.

Diameter: 0.36 to 0.45 mm; thickness: 0.32 to 0.40 mm.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss, near Baden. Originally from the Miocene of California.

Pullenia quinqueloba (Reuss)

Plate 7, figures 19a, b

Nonionina quinqueloba REUSS, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 71, pl. 5, fig. 31.

Pullenia quinqueloba (Reuss) BRADY, 1884, Challenger Rept., vol. 9, p. 617, pl. 84, figs. 14, 15; CUSHMAN, 1914, U. S. Nat. Mus. Bull. 71, pt. 4, p. 21, pl. 13, fig. 2; CUSHMAN, 1921, U. S. Nat. Mus. Bull. 100, pt. 4, p. 299; CUSHMAN, 1924, U. S. Nat. Mus. Bull. 104, pt. 5, p. 42, pl. 8, figs. 5-9, 11; MACFADYEN, 1930, Geol. Survey of Egypt, pt. 2, p. 96, pl. 4, fig. 6.

Test planispiral, involute, somewhat compressed, periphery rounded, somewhat angled, slightly lobulate. Chambers increasing gradually in size as added, typically five visible in the last-formed whorl, rather uni-

form in shape. Sutures slightly depressed, somewhat curved, radial; wall calcareous, smooth, finely perforate. Aperture low, extending to the umbilicus on either side. Apertural face comparatively high, with the greatest height in the median line.

Diameter: 0.46 mm; thickness: 0.27 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna, Stephansche Ziegelei, Sooss, and from Baden. Recorded from the Oligocene of Alsace, Miocene of central Europe, Bulgaria, Australia, Egypt; Pliocene of Italy, Spain, Ecuador, Belgium; Recent, cosmopolitan.

Subfamily SPHAERODININAE

Genus *Sphaeroidina* d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny

Sphaeroidina bulloides d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 267, mod. no. 65; PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 29, pl. 2, fig. 58; BRADY, 1884, Challenger Rept., vol. 9, p. 620, pl. 84, figs. 1-7; CUSHMAN, 1924, U. S. Nat. Mus. Bull. 104, pt. 5, p. 36, pl. 7, figs. 1-6.

Sphaeroidina austriaca d'ORBIGNY, 1846, Foram. foss. Vienne, p. 284, pl. 29, figs. 19-21; REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 387, pl. 51, figs. 3-19.

Sphaeroidina variabilis REUSS, 1851, Zeitschr. deutsche geol. Gesell., vol. 3, p. 88, pl. 7, figs. 61-64.

Sexloculina haueri CZJZEK, 1848, Haid. Nat. Abh., vol. 2, p. 149, pl. 13, figs. 35-38.

Test subspherical, formed by a varying number of chambers, arranged in a strongly involute spire, becoming somewhat irregular in the adult. Chambers inflated, rapidly increasing in size as added, sutures distinct, depressed, wall thin, calcareous, very smooth, polished, finely perforate, often somewhat translucent. Aperture semicircular, at the basal margin of the last-formed chamber, with a distinct, flat tooth.

Diameter: 0.32 to 0.56 mm.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss. Recorded from the Cretaceous of Rugen, France; Tertiary of Hungary, Germany, Vienna Basin, Italy, Spain, Nicobar Islands. Recent, cosmopolitan.

Family GLOBIGERINIDAE

Subfamily GLOBIGERININAE

Genus *Globigerina* d'Orbigny, 1826

Globigerina bulloides d'Orbigny

Globigerina bulloides d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 277, no. 1, mod. 17 and 76; d'ORBIGNY, 1846, Foram. foss. Vienne, p. 163, pl. 9, figs. 4-6; PARKER, JONES and BRADY, 1857, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 21, pl. 2, figs. 5, 6, p. 31, pl. 2, fig. 55; BRADY, 1884, Challenger Rept., vol. 9, p. 593, pl. 79, figs. 3-7; CUSHMAN, 1941, Contr. Cushman

Lab. Foram. Res., vol. 17, pt. 2, p. 38, pl. 10, figs. 1-13.

Globigerina diplostoma REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 373, pl. 47, figs. 9-10.

Test subtrochoid, consisting of two spiral turns, the latter occupying almost the whole of the test. Chambers subglobular, much inflated, rapidly increasing in size as added, four to the last whorl; ventral side of the test deeply umbilicate, aperture large, rounded, each chamber individually opening into the ventral umbilicus. Wall calcareous, thick, coarsely perforate, finely spinose and cancellated.

Diameter: 0.26 to 0.46 mm; thickness: 0.21 to 0.31 mm.

Remarks.—For extensive discussion, see Cushman (1941).

Occurrence.—Collected from the Beethovenaussicht, Vienna; the Stephansche Ziegelei, Sooss, and the Breyersche Ziegelei, Vöslau. Recorded from Cretaceous to Recent, cosmopolitan.

Globigerina concinna REUSS

Plate 8, figures 6a, b

Globigerina concinna REUSS, 1850, Denkschr. k. Akad. Wiss. Wien, vol. 1, p. 373, pl. 47, fig. 8; GALLOWAY and WISSLER, 1928, Jour. Paleon., vol. 1, p. 41, pl. 7, fig. 7; NUTTALL, 1932, Jour. Paleon., vol. 6, p. 29, pl. 6, figs. 9-11; CORYELL and MOSSMAN, 1942, Jour. Paleon., vol. 16, p. 238, pl. 36, figs. 26, 27.

Test a low trochoid spire, consisting of about 2½ whorls, last whorl consisting of five chambers, and occupying the larger part of the test. Chambers inflated, subglobular, very rapidly increasing in size as added, the last chamber often somewhat smaller than the preceding one. Wall finely spinose, coarsely perforate, thick. Aperture large, opening from each chamber individually into the extremely large, excavated umbilicus.

Diameter: 0.35 to 0.55 mm; thickness: 0.18 to 0.32 mm.

Remarks.—Several authors (Brady, etc.) consider *Globigerina concinna* as identical with *Globigerina bulloides*. The characters of *G. concinna* appear, however, to be very constant, differing from those of *G. bulloides* in the number of chambers (having five instead of four) and in the very large, excavated umbilicus.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss. Recorded from the Miocene of central Europe; Pliocene of California.

Globigerina cf. *inflata* d'Orbigny

Globigerina inflata d'ORBIGNY BRADY, 1884, Challenger Rept., vol. 9, p. 601, pl. 79, figs. 8-10; CUSHMAN, 1914, U. S. Nat. Mus. Bull. 71, pt. 4, p. 8, pl. 4, figs. 4-8; CUSHMAN, 1924, U. S. Nat. Mus. Bull. 104, pt. 5, pl. 3, figs. 1-3.

Test trochoid, somewhat involute, slightly compressed, consisting of numerous chambers, three whorls visible on the dorsal side, four to five chambers in the last whorl. Chambers distinct, inflated, rapidly increasing in size as added. Sutures distinct, depressed, straight. Wall thin, smooth, distinctly perforate. Aperture a large, gaping opening, extending from the periphery to the ventral umbilicus.

Diameter: 0.29 to 0.53 mm; thickness: 0.27 to 0.42 mm.

Remarks.—The specimens from the Vienna Basin are very similar in outline to the figures of Brady and of Cushman, but lack the globigerine spinose wall, having instead a rather smooth wall; also the aperture is somewhat lower and more regularly formed than those of the other references.

Occurrence.—Collected from the Breyersche Ziegelei, Vöslau. Recorded from the Pliocene of western Europe; Recent very widely distributed.

Genus *Globigerinoides* Cushman, 1927

Globigerinoides rubra (d'Orbigny)

Globigerina rubra d'ORBIGNY, 1839, *Foram. Cuba*, in de la Sagra, *Hist. Nat. Cuba*, p. 94, pl. 4, figs. 12-14; BRADY, 1884, *Challenger Rept.*, vol. 9, p. 602, pl. 79, figs. 11-16; CUSHMAN, 1914, *U. S. Nat. Mus. Bull.* 71, pt. 4, p. 9, pl. 3, figs. 6-9.

Test an elongate trochoid spire, consisting of about three whorls, chambers much inflated, very rapidly increasing in size as added, numerous, the last whorl of three chambers occupying about one-half the test. Wall calcareous, finely cancellated, spinose, distinctly perforate. Aperture semicircular, at the base of the last-formed chamber, numerous secondary apertures along the sutures at the ventral sides of the preceding chambers.

Diameter: 0.42 mm; length: 0.42 mm.

Remarks.—Our single specimen is not as elongate as those figured by Brady. The general characters coincide rather well however, although it is difficult to determine from a single specimen if it is not actually an aberrant form of *G. trilobularis*.

Occurrence.—Collected from the Stephansche Ziegelei, Sooss. Recent, very cosmopolitan.

Globigerinoides triloba (Reuss)

Globigerina triloba REUSS, 1850, *Denkschr. k. Akad. Wiss. Wien*, vol. 1, p. 374, pl. 47, fig. 11.

Globigerina bulloides var. *triloba* REUSS, BRADY, 1884, *Challenger Rept.*, vol. 9, p. 595, pl. 79, figs. 1, 2, pl. 81, figs. 2, 3.

Globigerinoides triloba (Reuss) CORYELL and MOSSMAN, 1942, *Jour. Paleon.*, vol. 16, p. 238, pl. 36, figs. 29, 30.

Test sub-trochoid, consisting of two whorls, the last whorl consisting of three chambers, which occupy almost the entire test, the last chamber taking about one-half or more of the test. Wall calcareous, coarsely perforate, finely spinose and cancellate. Aperture ventral, rather small, at the base of the last-formed chamber. Secondary apertures on the sutures on the dorsal side of the test.

Length: 0.28 to 0.49 mm; breadth: 0.21 to 0.42 mm; thickness: 0.17 to 0.35 mm.

Remarks.—The specimens figured by Brady (1884) have been reidentified by Thalmann as *G. tricamerata* Tolmachoff, 1934.

The distinction between this species and *G. trilobularis* d'Orbigny, is not marked.

Occurrence.—Collected from the Beethovenaussicht, Vienna; Stephansche Ziegelei, Sooss, Breyersche Ziegelei, Vöslau, and from the railway cut near Vöslau.

Genus *Globigerinella* Cushman, 1927

Globigerinella aequilateralis (Brady)

Globigerina aequilateralis BRADY, 1884, *Challenger Rept.*, vol. 9, p. 605, pl. 80, figs. 18-21.

Cassidulina globulosa (part) EGGER, 1857, *Neues Jahrb.*, p. 296, pl. 11, fig. 4.

Test planispiral, loosely coiled, five or more chambers visible, strongly evolute. Chambers inflated, globular, increasing rapidly in size as added; sutures distinct, depressed, wall calcareous, distinctly perforate, finely hispid. Aperture large, semicircular, in the umbilical face of the chamber. Periphery broadly rounded.

Length: 0.45 mm; breadth: 0.38 mm; thickness: 0.32 mm.

Occurrence.—Collected from the Breyersche Ziegelei, Vöslau. Rare. Recorded from the Recent, North Atlantic, North and South Pacific, pelagic.

Family ANOMALINIDAE

Subfamily ANOMALININAE

Genus *Anomalina* d'Orbigny, 1826

Anomalina sp.

Plate 8, figures 5a, b

Test evolute, compressed, nearly bilaterally symmetrical; periphery subacute, adult specimens consisting of about two whorls. Chambers distinct, about twelve in adult specimens, very gradually increasing in size as added. Sutures distinct, very slightly curved, strongly limbate, somewhat raised, forming a stellate design. Aperture peripheral, extending somewhat to the ventral side, consisting of a low slit at the base of the triangular apertural face. Wall smooth, with a glassy lustre, finely perforate except for the sutures. In the megalospheric forms, the first whorl is largely occupied by the inflated initial chamber.

Diameter: 0.49 mm; thickness: 0.21 mm.

Remarks.—Originally it was my intention to describe this *Anomalina* as a new species, but as it is quite rare, only three specimens having been obtained, I do not consider it advisable to add to the general overcrowding in smaller foraminiferal taxonomy.

Subfamily CIBICIDININAE

Genus *Cibicides* Montfort, 1808

Cibicides cf. *aknerianus* (d'Orbigny)

Rotalina akneriana d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 156, pl. 8, figs. 13-15.

Test trochoid, compressed, ventral side convex, dorsal side flattened to concave, consisting of two whorls, eight to nine chambers visible in the last whorl, ventral side with a small umbilicus. Periphery acutely rounded, chambers increasing rather rapidly in size as added, somewhat inflated, sutures depressed, curved. Wall calcareous, very distinctly perforate. Aperture peripheral, extending dorsally along the base of the chambers.

Diameter: 0.49 to 0.84 mm; thickness: 0.24 to 0.48 mm.

Remarks.—The specimen described by Nuttall (1932, *Jour. Paleon.*, vol. 6, p. 32, pl. 9, figs. 1-3) as *Cibicides aknerianus*, is probably not identical, having a much more acute periphery, much narrower chambers, and a more densely coiled dorsal side than is shown by the original type-figure.

Occurrence.—Collected from the Beethovenaussicht, Vienna, and from Roth-Neusiedl.

Cibicides austriacus (d'Orbigny)

Anomalina austriaca d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 172, pl. 10, figs. 4-9.

Rotalina cryptomphala REUSS, 1850, *Denkschr. k. Akad. Wiss. Wien*, vol. 1, p. 371, pl. 47, fig. 2; EGGER, 1857, *Neues Jahrb.*, p. 277, pl. 9, figs. 5-7.

Test trochoid, about two whorls to the adult specimen, nine to 12 chambers in the last whorl; ventral side convex, umbilicate, dorsal side flattened to convex. Periphery subacute, lobulate, chambers comparatively low, becoming more inflated in the adult stage, increasing rather rapidly in size as added. Sutures depressed, except for the dorsal initial part where they are somewhat limbate, curved. Wall calcareous, coarsely perforate, aperture peripheral, becoming dorsal, a narrow slit at the base of the last-formed chamber, extending ventrally along the base of the chambers.

Diameter: 0.41 to 0.87 mm; thickness: 0.17 to 0.28 mm.

Occurrence.—Collected from the Ziegelei Heiligenstadt and from the Stephansche Ziegelei, Sooss. Rather

common. Recorded from the Oligo-Miocene of Germany and central Europe.

Cibicides boueanus (d'Orbigny)

Plate 8, figures 9a, b

Truncatulina boueana d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 169, pl. 9, figs. 24-26.

Test trochoid, much compressed, elongate to oval in outline, ventrally convex, flattened or concave dorsally, periphery acute, ventral side slightly umbilicate. Chambers narrow, not inflated, except occasionally the last-formed one. Sutures very distinct, limbate, curved, flush with the surface. Wall calcareous, thin, often somewhat translucent, distinctly perforate. Aperture ventral, becoming dorsal, a narrow slit at the base of the last-formed chamber.

Length: 0.28 to 0.66 mm; breadth: 0.22 to 0.54 mm; thickness: 0.09 to 0.23 mm.

Remarks.—Although considered by Brady as synonymous with *Cibicides lobatulus*, *C. boueanus* may easily be distinguished by its very regular form, uninflated chambers, and non-depressed limbate sutures.

Occurrence.—Collected from the Beethovenaussicht, Vienna, Roth-Neusiedl, and Baden.

Cibicides dutemplei (d'Orbigny)

Rotalina dutemplei d'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 157, pl. 8, figs. 19-21; EGGER, 1857, *Neues Jahrb.*, p. 274, pl. 7, fig. 8.

Rotalina conoidea CZJZEK, 1848, *Haid. Nat. Abhandl.* vol. 2, p. 145, pl. 13, figs. 4-6.

Rotalina bruckneri REUSS, 1855, *Zeitschr. deutsche geol. Gesell.*, vol. 7, p. 273, pl. 12, fig. 7.

Test trochoid, slightly compressed, more convex ventrally than dorsally, three to four whorls in an adult specimen, eight to nine chambers in the last whorl. Chambers distinct, very slightly inflated, very gradually increasing in size as added; sutures distinct, limbate, curved ventrally, straight dorsally but strongly oblique and becoming somewhat indistinct towards the center. Sutures often somewhat depressed ventrally. Umbo small, shallow or not apparent. Periphery subacute. Wall smooth, very distinctly perforate. Aperture peripheral, extending ventrally along the base of the chambers; a low arched opening at the base of the last-formed chamber.

Diameter: 0.70 to 1.16 mm; thickness: 0.42 to 0.52 mm.

Remarks.—*Truncatulina dutemplei* Brady (1884, *Challenger Rept.*, vol. 9, p. 665, pl. 95, fig. 5) is in no way identical with the original species of d'Orbigny, from the Vienna Basin.

Occurrence.—Found in most of the Vienna Basin localities. Common to abundant. Recorded from the Miocene of southern Germany.

Cibicides lobatulus (Walker and Jacob)

Nautilus lobatulus WALKER and JACOB, 1798, Adams Essays, Kanm. ed., p. 642, pl. 14, fig. 36.

Truncatulina tuberculata D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 279, mod. 37.

Truncatulina lobatula (Walker and Jacob) D'ORBIGNY, 1846, Foram. foss. Vienne, p. 168, pl. 9, figs. 18-23; BRADY, 1884, Challenger Rept., vol. 9, p. 660, pl. 115, figs. 4, 5; CUSHMAN, 1910, U. S. Nat. Mus. Bull. 71, pt. 5, p. 31, pl. 15, fig. 1.

Anomalina variolata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 170, pl. 9, figs. 27-29.

Truncatulina communis REUSS, 1855, Sitz. Akad. Wiss. Wien, vol. 18, p. 242, pl. 5, fig. 56.

Truncatulina dekayi REUSS, 1861, Ibid., vol. 44, p. 338, pl. 7, fig. 6.

Cibicides lobatula (Walker and Jacob) CUSHMAN, 1931, U. S. Nat. Mus. Bull. 104, pt. 8, p. 118, pl. 21, figs. 3a-c.

As the species is exceedingly common, there is no need for another complete description.

Dimensions of the Vienna Basin forms: Length: 0.45 mm to 0.85 mm; breadth: 0.24 to 0.76 mm; thickness: 0.14 to 0.22 mm.

Occurrence.—Collected from the Beethovenaussicht, Vienna, the Breyersche Ziegelei, Vöslau, the railway cut near Vöslau, and from the Ziegelei Heiligenstadt.

Cibicides ungerianus (d'Orbigny)

Plate 8, figures 2a, b

Truncatulina ungeriana D'ORBIGNY, 1846, Foram. foss. Vienne, p. 157, pl. 8, figs. 16-18; ? NUTTALL, 1932, Jour. Paleon., vol. 6, p. 34, pl. 9, figs. 4-6.

Test trochoid, much compressed, periphery acute, with a narrow keel of transparent material, two to three whorls visible dorsally, only the ten chambers of the last whorl visible ventrally. Umbilical region open on the dorsal side, showing the older volutions, but filled or covered with granular shell material. Chambers rapidly increasing in size as added, becoming slightly inflated in the adult. Sutures curved, limbate, becoming depressed, in the adult, somewhat raised dorsally in the early portion. Wall calcareous, smooth, but very distinctly perforate. Aperture a narrow slit at the base of the last-formed chamber, extending from the ventral to the dorsal side.

Diameter: 0.36 to 0.59 mm; thickness: 0.14 to 0.22 mm.

Remarks.—The figure given by Nuttall of a specimen from the Oligocene of Mexico, lacks the typical granulose matter in the dorsal umbo. As this is an essential characteristic of the typical forms, Nuttall's specimen would best be made a variety of the type.

Occurrence.—The Stephansche Ziegelei, Sooss; the Beethovenaussicht, Vienna, Baden and Roth-Neusiedl.

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